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Index to Advertisers and Classified Index Following Reading Matter.

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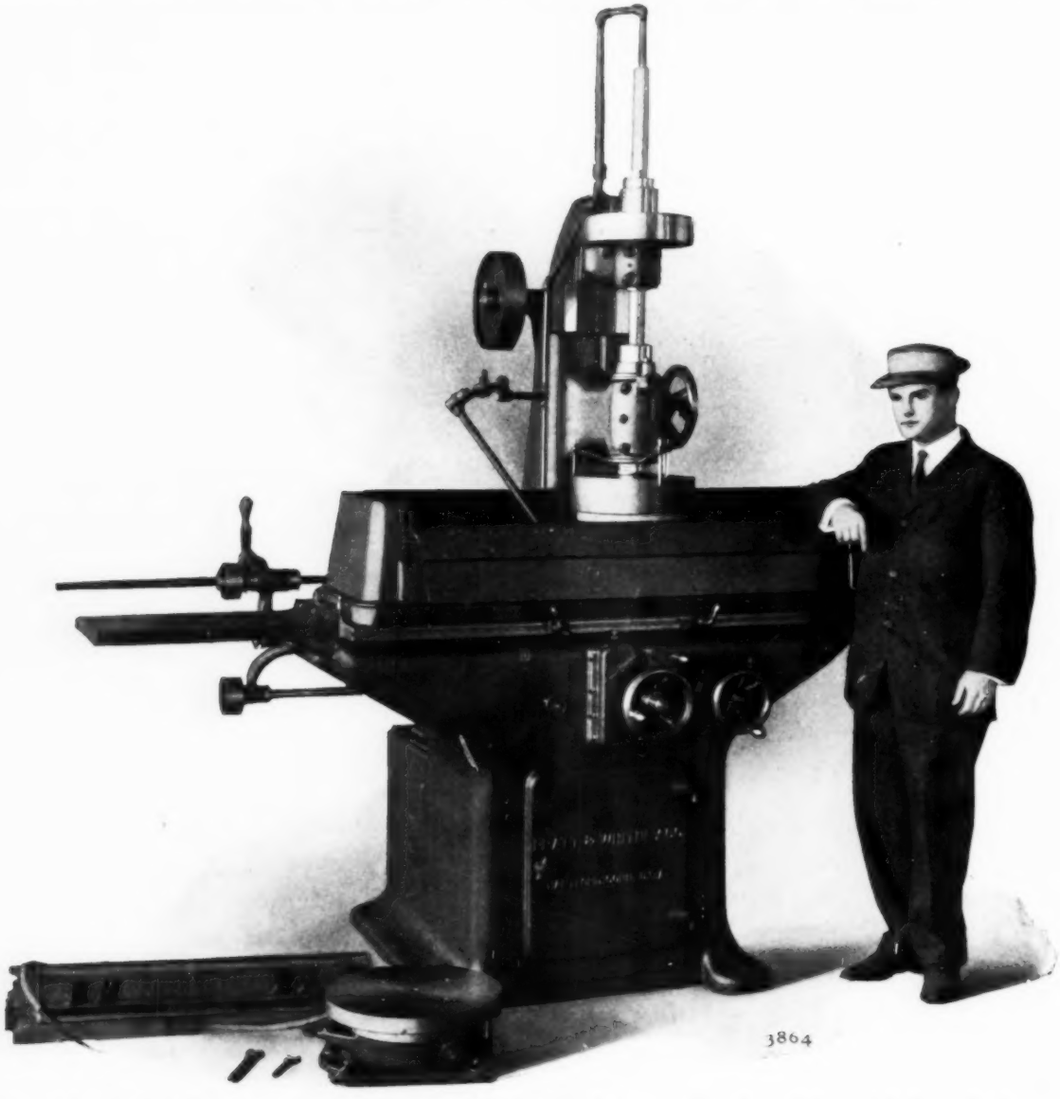

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Press Tools Used in Clock Manufacture

Sub Press and Other Punches and Dies Are Made by the Seth Thomas Clock Company for Producing Clock Frames, Hands, etc.

BY CHARLES DOESCHER

The Seth Thomas Clock Company, of Thomaston, Conn., makes most of its own dies, and the accompanying drawings show some original ideas that the concern has perfected and introduced from time to time in connection with its diemaking methods in order to obtain the best possible results. I am indebted to the kindness of C. H. Bell, foreman of the die room and G. B. Buckland, head diemaker, for many of the facts obtained during a recent visit to the works of this company.

The set of pillar-press tools, shown in Figs. 1 to 3, produce the circular clock plate in Fig. 4. That press tools constructed as here shown will accomplish all that is desired, may be illustrated by referring to Fig. 5, which shows a brass clock plate 0.055 thick made in one operation and containing 53 holes, many of the holes being of the same diameter as the thickness of the metal; yet seven tons were cut at one run without the breaking of a punch or a minute's stop for repairs.

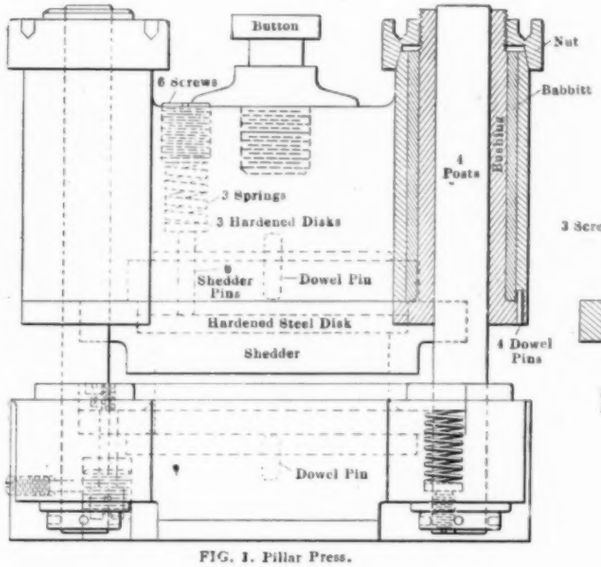


FIG. 1. Pillar Press.

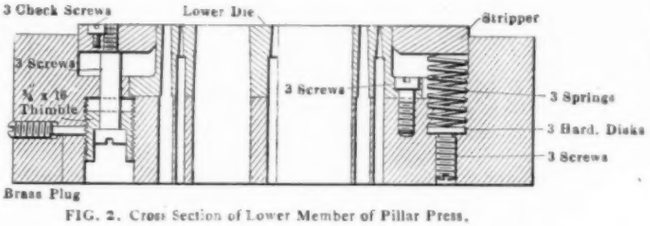


FIG. 2. Cross Section of Lower Member of Pillar Press.

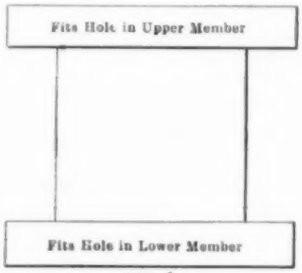


FIG. 6

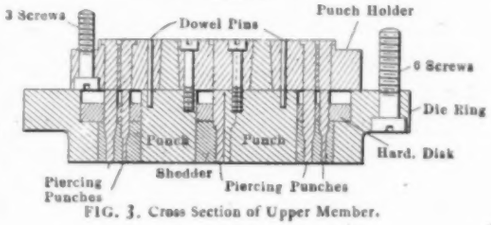


FIG. 3. Cross Section of Upper Member.

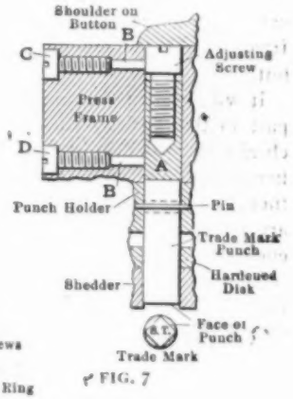


FIG. 7

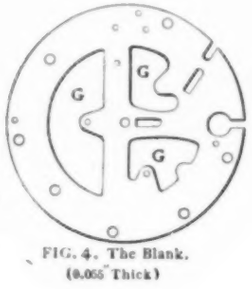


FIG. 4. The Blank. (0.055" Thick)

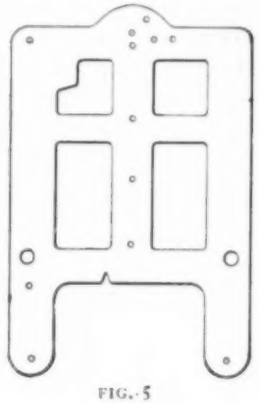


FIG. 5

PRESS TOOLS FOR CLOCK PLATES

A Novel Set of Pillar-press Tools

Making a set of tools for cutting out clock plates, or clock frames, as they are also called, that will stand up and run day after day without requiring the services of a diemaker to keep them going is an A-1 job, as clock plates are usually made of, say, 0.050-inch metal, and have anywhere from 25 to 50 or more holes pierced, many of the holes being of the same diameter as the thickness of the metal. It is, therefore, obvious, that not only the punch and die, but the press itself that holds the punch and die in position and in correct relation to each other, must be properly made in order to give satisfactory results.

Fig. 1 gives a general idea as to the construction of the tools which are used for cutting out the circular plate, shown in Fig. 4, which is made of 0.055 metal and has 28 holes pierced and seven prick-punch marks which are all made in one operation. When it happens that the required size of certain holes is less than the thickness of the metal to be used, the locations for these holes are pricked by a punch made similar to the round piercing punches, except that it is pointed and made a trifle shorter. This saves the time of drilling out the holes later on by the aid of a drill jig.

The Construction of the Tools

After the upper and lower members have been machined and the four pillar posts placed in position, as shown in Fig. 1, the fixture shown in Fig. 6, which fits the hole recessed out for the lower die, is set in, and the upper member slipped over until the bottom of the hole recessed out for the punch holder rests on the fixture, thereby bringing the upper and lower holes exactly in line with each other.

The babbitt is next poured into the open space between the bushings and the frame of the press, and is composed of a special mixture, which has been found to be less

liable to shrinkage than any other composition they have experimented with, and is as follows: Six parts of lead, two parts of tin, one part of bismuth, one part of antimony.

When thoroughly cool the upper member is worked up and down to detect any unnecessary play or looseness of fit; also to see if the upper and lower holes are in an exact alinement with each other. The flanges on the bushings are then secured to the frame of the press by four pins, and the four projecting shoulders of the frame of the press near the threaded part of the bushings are now beveled off by a special revolving cutter which has a projecting tit which fits the hole in the bushing. The nut which screws onto the bushing is beveled on the inside to correspond with the bevel on the frame of the press. When the nuts are tightened up, they not only prevent the bushings from working down, but also hold them central with the beveled shoulders on the frame of the press regardless of the babbitt.

It will be seen that the babbitt plays no part in the working of the tools, that its chief aim is to help line up the upper and lower members with each other and hold them in this position until the bushings are pinned in position and the nuts tightened up.

Fig. 2 shows a cross-section view of the working parts of the lower member of the pillar press.

The Lower Die

The lower die is held in place by three ¼-inch fillister-head screws in the flanged part of the die which fits in the recess of the press and is further prevented from turning by a ¼-inch locating pin; this pin also locates the die in its exact position whenever it is taken out and put back in place.

By referring to the clock plate, Fig. 4, the shape of the face of the die can be readily seen; the die is made from an accurate master plate containing the various holes which are in the exact position and relation to each other required.

The Stripper

The stripper is made a nice sliding fit on the outside of the lower die, and strips the metal from which the plates are cut from this die by the aid of three springs, as shown.

A very ingenious method is used to control the upward motion of this stripper. Of the various methods tried in the past by this concern the one illustrated has proved to be the best, and is now used in connection with all dies of this kind; also when occasion requires on regular sub-press tools.

As shown, the threaded part of the three screws that screw into the stripper from the bottom are prevented from working loose by the three check screws that are screwed into the face of the stripper. The threaded thimble is drilled and counterbored to receive the head of the screw, as shown, and has a screwdriver slot by which it is screwed into the frame of the press. This thimble controls the upward motion of the stripper and is prevented from turning or loosening by a headless screw which forces the brass plug into the threaded part of the thimble, as shown in Fig. 2.

The Upper Die Ring

Fig. 3 shows the working parts of the upper member of the pillar press and consists of the upper die ring which is held in place by six 5/16-inch fillister-head screws. The inside of this die ring fits the outside of the lower die and cuts the circular or outside form of the clock plate, as shown in Fig. 4.

The Shedder

The shedder is made a nice sliding fit in the hole in the die ring, and not only sheds the clock plates from the punches, but helps to keep the punches in line with the lower die, and also supports them and prevents them from springing or breaking.

The holes in the shedder for the different punches are transfered from the lower die after the die is hardened and set in place. The shedder is left soft for fear of distortion of the steel in hardening; so that the holes for the punches are in an exact line with the holes in the lower die and this plays a most important part in the successful working of the tools.

Securely fastened to this shedder by the aid of screws and dowel pins is a hardened steel disk, upon which six pins are continually pressed by springs, as shown in Fig. 1. The holes in this disk for the punches are made large enough so that the punches do not come in contact with it. The hardened disk prevents the shedder from being roughed up by the six operating pins.

The Punch Holder

The punch holder, Fig. 3, for different punches is held in the upper member of the press by three ¼-inch fillister-head screws and a ¼-inch locating pin. The holes into which the various punches are driven are laid out from the same master plate that was used in laying out the holes in the lower die.

The Punches

The piercing punches are lightly driven in from the back and are prevented from pulling through by the flanged head, as shown. The punches which cut out the larger of the irregular holes which are marked *G* in Fig. 4, have taper shanks which are driven into the punch holder, and are still more firmly held in place by the aid of screws and dowel pins.

Stamping the Trade-mark

When it so happens that the clock plates are to be stamped with a trade-mark, or lettered or numbered in any way, the device shown in Fig. 7, is used in connection with the tools described. The operation is done at the same time the plate is cut and pierced without added expense insofar as the operation itself is concerned.

This method, which is original with the Seth Thomas Clock Company, is the result of considerable experimenting, and is at present used when required on all tools of this type with the best of results.

Referring to Fig. 7, the trade-mark punch, the outside of which is made a nice sliding fit in the shedder, is lightly driven into the punch holder. The steel pin shown not only prevents the punch from turning and dropping through in case it becomes loose in any way, but also helps to locate it in its proper position when put back in place after it has been taken out. The hole for the pin is elongated to allow for the adjustment of the punch.

The distance from the face of the trade-mark punch upon which the design for the trade-mark is cut to the face of the shedder is equal to the thickness of the metal to be used. The round steel piece *A*, together with the adjusting screw, forms the means for adjusting the trade-mark punch in order to give the proper depth to the trade-mark when stamped on the clock plate. The adjusting screw bears against the shoulder of the button as represented and is prevented from loosening by the brass plug *B* which is forced against the head of the screw by the screw *C*. The screw *D* prevents the part *A* from loosening and also prevents it from turning when the adjusting screw is raised or lowered.

It should be stated that the four pillar posts have the usual spiral grooves to facilitate oiling; also that the arrangement for feeding and guiding the metal in connection with these tools is not shown, but is similar to those that have been described in the American Machinist from time to time and needs no explanation.

A Novel Set of Subpress Tools

Articles pertaining to the construction and use of subpress dies have so often appeared in these columns that it would seem that very little, if anything, could be added to what has already been said. For this reason the working parts only of the subpress tools shown here are described.

This set of subpress tools is of more than ordinary interest, due to the fact that they cut and pierce four blanks at one time. Fig. 8 shows the lower member of the subpress with a plan of the punches and work just above in Fig. 9. Fig. 8 includes the usual form of stripper whose upward motion is controlled in the manner indicated; it is similar in construction to the one already described in connection with Fig. 1.

The Stripper

The face of the stripper is represented

in Fig. 10 and is made in five parts, as shown, to facilitate the working out of the irregular-shaped holes which are made a sliding fit for the blanking punches.

The small, round hole numbered 1 is the hole where the punch comes through which pierces the hole in the metal for the gage pin. This punch is held in place in the lower member of the subpress, and is shown in Fig. 9.

Hole 2 is the escape hole for the punchings from the gage-pin hole, while the hole numbered 3 is the hole for the gage pin.

Laying Out the Die

In laying out the die there were three important points taken into consideration: The first was to construct the die so that it would be strong enough to do the work. The second was to lay the die out so that the greatest number of blanks would be cut from the least amount of metal. The third was to lay out the die accurately so that there would be no "running in," that is to say, no cutting of imperfect or half-blanks when running the metal through on account of "a wrong layout."

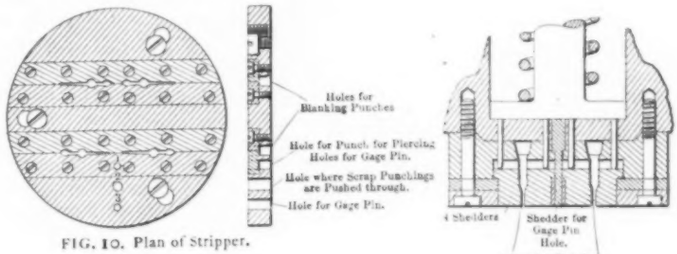

Holes for Blanking Punches
Hole for Punch for Piercing Holes for Gage Pin.
Hole where Scrap Punchings are Pushed through.
Hole for Gage Pin.
4 Sheldera
Shedder for Gage Pin Hole.
4 Piercing Punches.

FIG. 10. Plan of Stripper.

FIG. 12. Upper Member.

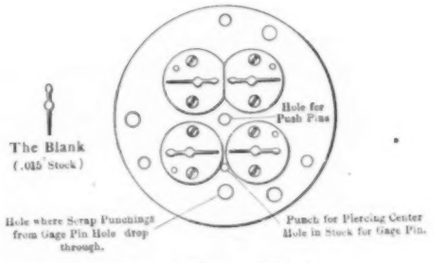

The Blank (.015 Stock)
Hole for Push Pins
Hole where Scrap Punchings from Gage Pin Hole drop through.
Punch for Piercing Center Hole in Stock for Gage Pin.

FIG. 9. Plan of Punches and Work.

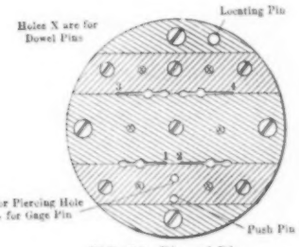


FIG. 11. Plan of Die.

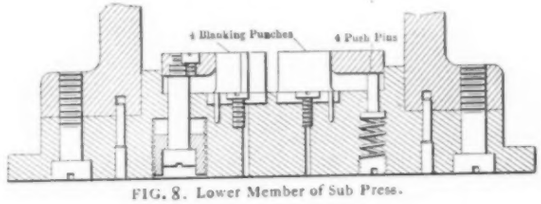


FIG. 8. Lower Member of Sub Press.

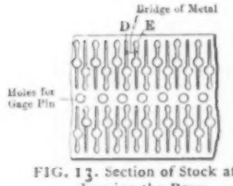


FIG. 13. Section of Stock after Leaving the Press.

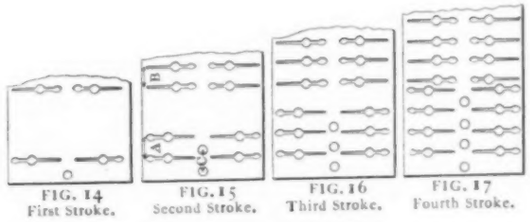


FIG. 14 First Stroke. FIG. 15 Second Stroke. FIG. 16 Third Stroke. FIG. 17 Fourth Stroke.

SUB PRESS TOOLS

The Blanking Punches

The manner in which the blanking punches are held in position in the lower member is shown in Figs. 8 and 9. Fig. 9 shows the punches in position with the stripper removed. The round flanges on the blanking punches are fitted into the recessed holes and are held in place by screws and dowel pins. The punches when in use perform the function of both punch and die, as the punches also act as piercing dies for the small, round hole in the blank. The holes marked *A* in Fig. 8 are the escape holes for the scrap punchings that are thus pierced out.

The Construction of the Die

Figs. 11 and 12 show that the die is made in five sections which are held in place by screws and dowel pins. The die itself is held in the upper member of the press by four fillister-head screws and the usual locating pin.

By referring to Fig. 13, which shows a strip of metal after it has been run through the press, it can be seen that the metal is pretty well used up; that there is very little stock left that has not been converted into blanks.

Fig. 11 shows the layout of the die, which is made so that the points numbered 1 and 2 point toward each other, while the points numbered 3 and 4 point just the opposite way. This is done to allow the holes in the metal from which the blanks have been cut to match up more closely with each other; that is, more metal would be wasted if the die was laid out so that the circular bodies of the blanks were all cut in a straight line with each other.

Accuracy in Layout

In laying out the die the first step to be taken after the manner in which the blanks are to be cut from the metal has been decided upon, is to find the distance from *D* to *E*, Fig. 13, which is done by adding the width of the blank to the bridge of metal. In order to make the die strong the irregular holes are spread apart in the manner shown in Fig. 11. The distance from the center of these holes (which are numbered 1 and 3, 2 and 4) is accurately spaced off, by taking the distance from the center of the hole *D* to the center of the hole *E* in consideration. In this case the distance from the center of 1 to the center of 3 is seven times the distance from *D* to *E*. It can readily be seen that this distance must be exact, for the reason that if it was too long there would naturally be an unnecessary waste of metal, owing to the fact that there would be too large a bridge of metal between the holes after the metal had been run through. On the other hand, if this distance was too short the holes would run into each other as the metal was being gradually run through, which would mean that the blanks cut would be imperfect or half-blanks.

The distance that 1 and 2 should be located from each other is determined principally by the relative strength of the die between the holes, as is also the distance between 3 and 4.

Running the Metal Through

The metal is run through in the usual way by the aid of guide pins, not shown. The short section of metal shown in Figs. 14, 15, 16 and 17 clearly shows how the metal is run through from the start; also how the holes gradually match in with each other after the fourth stroke of the press.

It must be understood, however, that the blanks are pushed back into the metal by the upper shedders (shown in Fig. 12) after they are cut, and are taken out after the metal has been run through. The holes in the short strips of metal are drawn merely to give a clearer idea as to the manner in which the blanks are cut from the metal; also to enable the reader to more readily grasp the idea as to the manner in which the die is laid out.

Fig. 14 shows that on the first stroke of the press four blanks are cut, as is also the hole for the gage pin. The blanks are pushed back into the metal by the shedders, which also tend to straighten or flatten them out in doing so.

The scrap punching from the gage-pin hole is also pushed back into the metal by the shedder shown in Fig. 12, as there is no convenient way in which the punching can be gotten rid of by allowing it to escape by way of the upper member of the press.

Fig. 15 shows the metal after the second stroke. The scrap punching from the gage-pin hole that was cut on the first stroke of the press, is now pushed through the metal by a push pin shown in Fig. 11, and allowed to escape through the hole numbered 2 in the stripper shown in Fig. 10 and drops through the hole in the frame of the lower member of the press which is shown in Fig. 9.

By referring again to Fig. 15 it will be seen that the distance from the center of one gage-pin hole to the center of the next, as shown at *C*, is the same as the distance between the centers of the irregularly shaped holes *A* and the centers of *B*, and that after every stroke of the press the metal is fed or moved along just this distance, until the entire strip of metal has been run through.

After the second stroke of the press the gage-pin holes engage with the gage pin and form a position stop for the metal, thus preventing the feeding of the metal too far or not far enough when passing it through the dies.

Figs. 16 and 17 show the metal after the third and fourth stroke and also show how the holes in the strip gradually match up with each other until it appears like the strip shown in Fig. 13, after it has been run through.

Split Dies

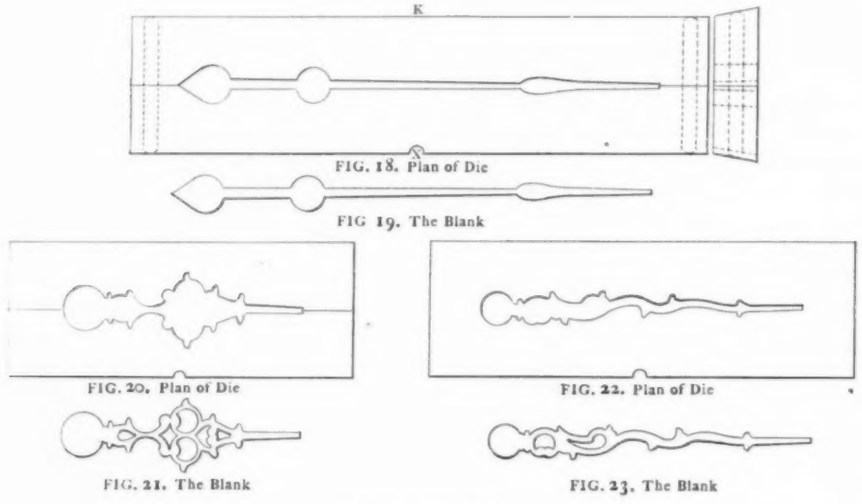
The split dies shown to reduced scale in Figs. 18 and 20 are used for blanking out clock hands, and are shown merely to give an idea as to the manner in which the blanking dies for this operation are made.

Fig. 18 represents a split die for blanking the long clock hand in Fig. 19. The two sections are doweled together in the manner indicated which prevents them from shifting endwise. When in use the die is held in the die bed by the usual key.

The semi-circular notch marked *X* engages with a round stud in the die bed and prevents the die from shifting in the bed when in use. This method is used by the Seth Thomas Clock Company, on all ordinary blanking dies, and while not being new is nevertheless one that should be made more use of than it really is. The key which locks the die in the bed is driven in on the other side of the die at *K*, Fig. 18.

Fig. 20 shows a split die that borders on the artistic, and is used for cutting the outside form of the clock hand in Fig. 21. The fancy perforations on the inside of the blank are made in a separate operation; the dies for which are similar to those that have appeared in the American Machinist before and, therefore, need no description at this time.

Fig. 22 is another artistic blanking die for the clock hand in Fig. 23. This die is not split for the reason that the blank is of such a design that it cannot be halved by a straight line. The perforations here are also left for a separate operation.

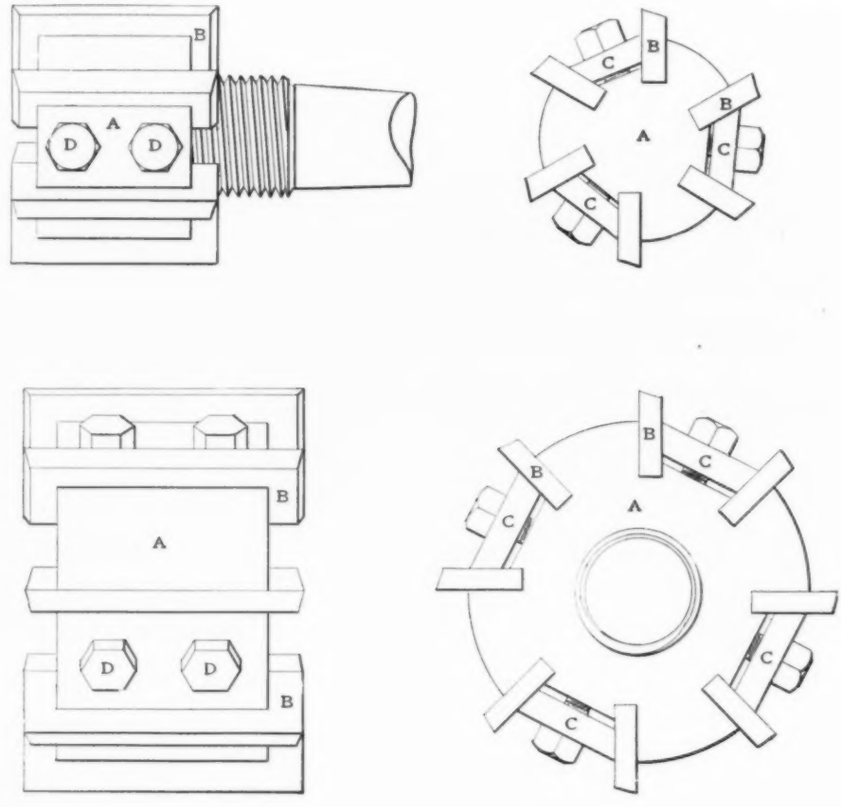


CLOCK HAND DIES

An Inserted-tooth Cutter

By Edwin Buswell

The cut shows a new inserted-blade milling cutter, which I have lately designed and made. The construction is simple and very rigid. The body *A* and clamp *C* are made of mild steel, case-hardened, and the cutter blades are of high-speed steel, *D* are clamping screws. I have used these cutters on steel, cast iron and aluminum with excellent results in finish and larger production than the other types; I have made form cutters of



END MILL AND SIDE MILL WITH INSERTED TEETH

the same construction with the same gratifying results. With this type the blades require no fitting whatever; take the bar of high-speed steel from stock, cut it up to the required lengths, harden and then mount them in the body for grinding. It is not necessary for the blades to fit; make the slot in the body a few thousandths wider than the thickness of the blade steel as supplied from the makers, and the clamps will keep them in place.

Pneumatic-Hydraulic Inclined Lift

By I. W. Chubb

The well-known Belgian firm of H. Bollinckx, Brussels, have in one part of their factory a difference of level and, although a sloping way had been arranged, the firm experienced loss of time due to it. The difference of level is about 4 feet 9 inches, and it was not considered advisable to use a direct lift or elevator because the parts to be raised or lowered were long and not easily got into a cage or car. A wagon or truck of the type shown in Fig. 1 was therefore employed to run along an inclined way; the length traveled (measured horizontally) is 11½ feet. Some of the details of construction are seen in the line drawing (Fig. 3) but the photograph-reproductions explain the working.

A stationary cylinder *E*, filled with water and connected with a tank *C* placed alongside the wall, provides the necessary power for lifting. A cock *B* in the water circuit is shut if the wagon *P* is to remain in any required position. This is obviously of importance to prevent the wagon and load sliding back. The tank is connected with the compressed-air piping *F* of the works. When the wagon is at the top of the incline, the compressed air is let out through the piping *O*. Then the cock mentioned, between the cylinder and tank, is opened by raising the counterweight *M* and the wagon will fall in 30 seconds; the water is driven by the piston into the tank. When the load is down, of course, the counterweight is dropped and the cock shut. It would be possible at that moment to open the air cock again so that the system might be got ready sooner for lifting, as the water cannot pass from the tank to the cylinder. The lift is, of course, by the pressure of water on the piston and performs its work in a very satisfactory manner.

An improved apparatus for the design of slide-valve gears was recently demonstrated at the Royal Scottish Society of Arts in which a baseboard with two eccentrics mounted upon a crank shaft at one end is used. The shaft is so arranged that the eccentrics and angles of advance may be varied and accurately measured.

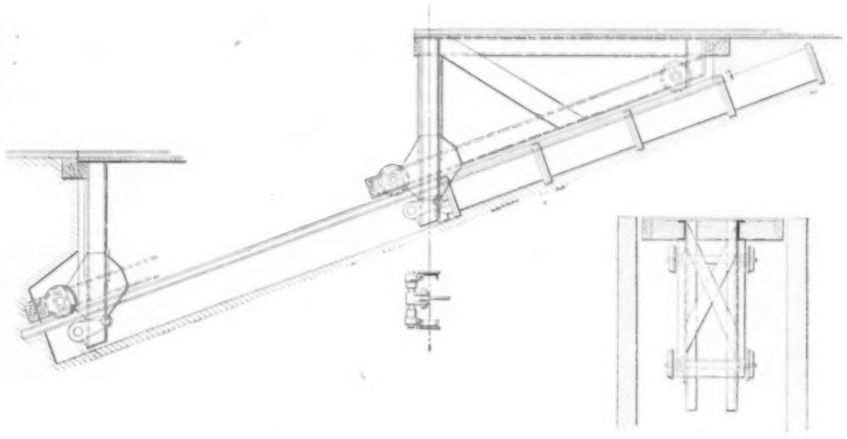


FIG. 3. DETAIL OF INCLINED SHOP LIFT

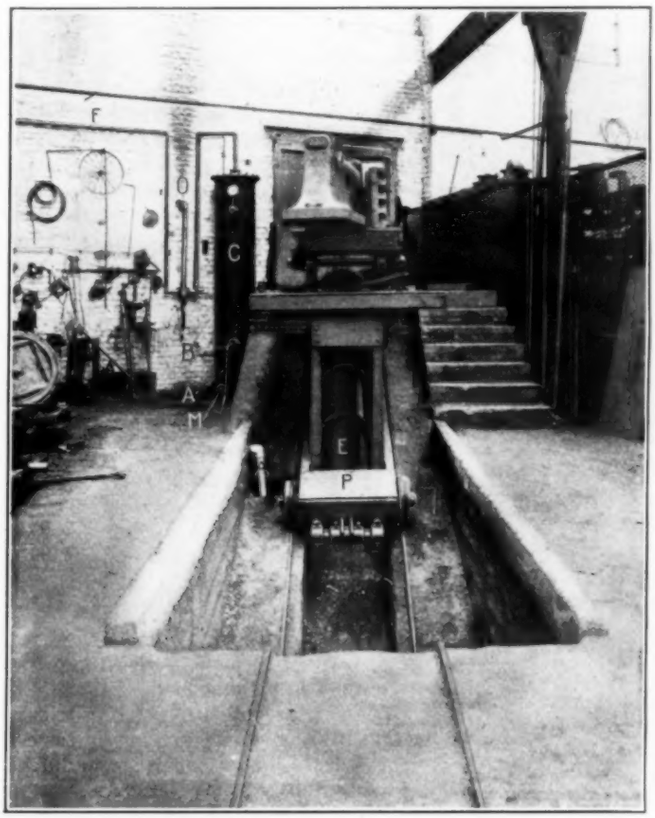


FIG. 1

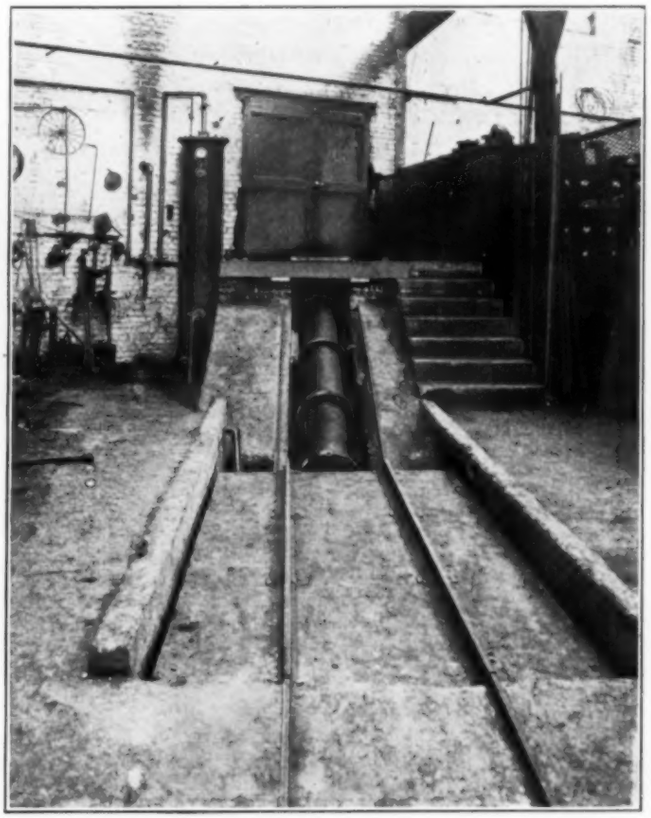


FIG. 2

AN INCLINED LIFT IN A BELGIAN SHOP

The Making of Large Drop Forgings

Different Operations in Forging a 400 Pound Crank Shaft. Machines, Dies and Steel Used. Temperature at Which to Forge

BY E. F. LAKE

The snail case, steel casting shown in Fig. 1 was recently cast by the Falk Company, of Milwaukee, Wis. It is one of the largest steel castings that has been made and the half-tone shows it just after it was lifted out of the mold by the 50-ton traveling crane. It weighs 83,530 pounds and was cast for the Allis-Chalmers Company.

When the machine work is all finished on this casting, it will be in two pieces, that are to be bolted together, at the flanges on each side of the chain with which it was lifted, and the flanges on each side of the opening at the bottom of the half-tone.

The making of the mold and cores of such a large steel casting requires a great deal of skill on the part of the molders and core-makers, as well as a knowledge of the way the hot metal will act when poured into the mold. The center of the cores are usually filled with coke, or some other coarse material, so as to reduce the volume of gases that are liable to form from the hot metal coming in contact with the core sands and the materials used as binders. This also makes air spaces in the center of the cores, in which the gases that do generate can collect and be carried out of the mold through vents that are run out of the core through any openings which may be in the top of the casting.

Steel Casting Molding

For steel castings the molds must also be lined with clean, fresh sand of a nature that does not readily generate gases and they must be thoroughly dried before the hot metal is poured in them. For this

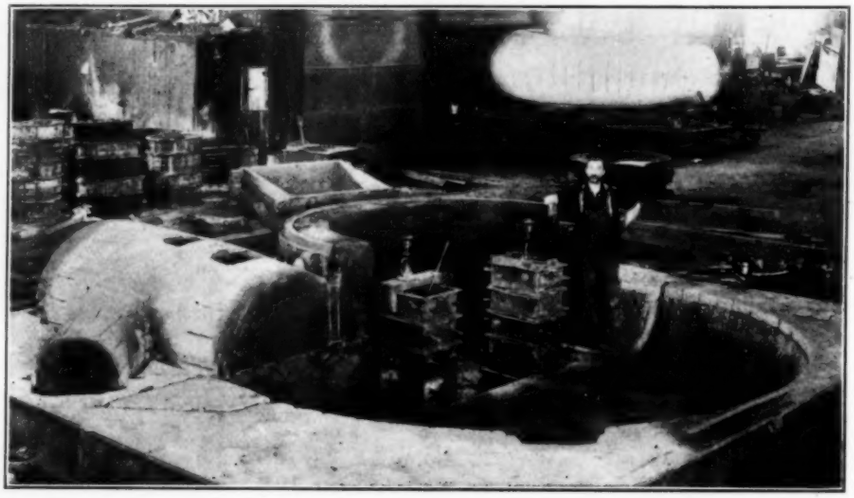


FIG. 2. DRAG OF MOLD WITH HALF THE CORE SET AND SHOWING POURENS

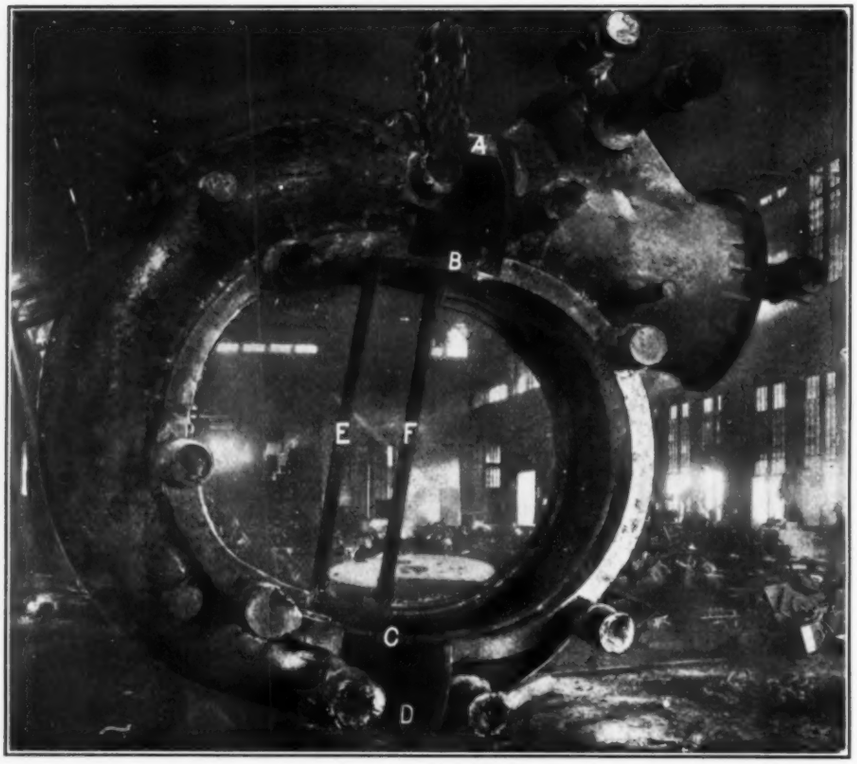


FIG. 1. CAST-STEEL SNAIL CASE BEING LIFTED OUT OF MOLD

reason ovens are provided with cars and tracks running into them similar to the one shown in the background of Fig. 2. This enables molds as large as this to be easily handled. To pour the hot steel in molds filled with green sand, that has not been dried out, would cause the gases to form so suddenly that they would cause an explosion.

The above rules for making molds for steel castings, as well as many other details, differ so much from the rules laid down for the making of molds for cast iron, that they have caused a division in the trade and a cast-iron molder is seldom successful as a molder of steel castings.

Risers must be liberally provided at all the high points in the mold, as shown on the face of the casting in Fig. 1, to prevent the metal from "cold shorting," and to carry away all of the slag, bad metal and foreign substances that may gather in the mold.

This piece could be made in two separate castings. But if molded in this way each piece would form a half circle and the shrinkage would not be the same on each one, owing to their being so different in shape on any cross-section.

To make them both shrink the same, so they will fit together well when machined,

they are cast in one piece, by binding them together with strips of metal, such as are shown at *A*, *B*, *C* and *D* in Fig. 1. These strips will be cut away when the casting is machined. The extra bars of metal at *E* and *F* are cast in the case as bottom pouring is made necessary on castings of this size, owing to the fact that if the metal was poured in at the top of the mold, it would, in falling, tear a hole in the sand and leave a big lump on the casting, or deform it in other ways.

FIG. 3. ANOTHER VIEW OF DRAG WITH ONE-HALF THE CORE IN POSITION

an added precaution against irregular shrinkage.

The Molds

The mold partly finished is shown in Fig. 2. This shows the drag half of the mold, after it has been rammed up and baked in the oven. One-half of the core is placed in position and the comparative size of the casting is well illustrated by the molder who is standing inside of the mold, and who, by the way, was by no means a small man.

The two piles of small flasks in the center of the mold are built up to form the pourens. Two bottom-pour ladlefuls of hot metal are poured into this mold at the same time; one to fill each half. At the bottom of the mold runners are formed that carry the metal from each pouren to the casting that is to be. This

In the background of Fig. 2 is seen the other half of the core. It is just being brought out from the drying oven, on a car, ready for placing in the mold. In Fig. 3 is shown another view of the mold in the same stage of construction.

Closing and Finishing the Mold

The mold as it is ready to close is shown in Fig. 4. This view shows the cores all located and the cope hanging from the crane, as it is being moved over to be lowered into its place.

When the cope is placed in position it is strongly clamped to the drag, to prevent them from spreading apart when the hot metal is poured in the mold. This by no means completes the molders' work, as the pourens in the center of the mold must be securely fastened in place; the vents from the cores are provided with a free passage; the openings for the risers prepared; and the center filled in with sand to hold the center cores in position, as well as to keep the runners in the bottom of the mold in place; and to prevent the passages from breaking out, that form the bars *E* and *F*, shown in Fig. 1.

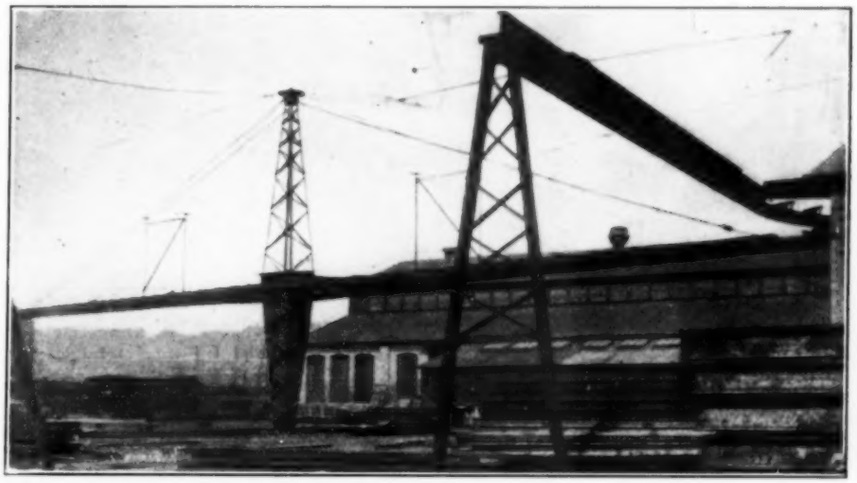


FIG. 5. REVOLVING CRANE IN YARD OF THE FALK COMPANY STEEL FOUNDRY

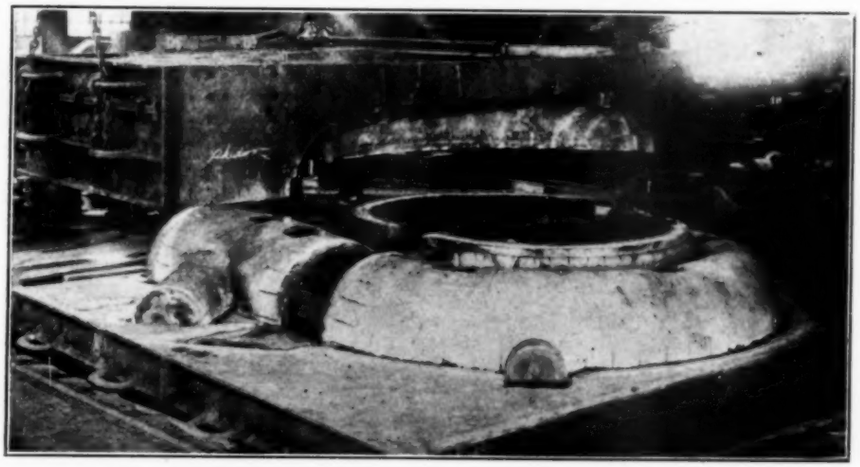


FIG. 4. THE CORES ALL LOCATED AND LOWERING THE COPE ON THE DRAG

Revolving Crane

Another interesting feature of The Falk Company's steel foundry is its revolving yard crane shown in Fig. 5. This crane was built from the company's own design, is of five tons capacity, and makes a complete circle 150 feet in diameter. It is used for laying out railroad track work, which is one of the large departments in this plant, and for transferring materials or castings from one building to another. Each building has tracks radiating toward the center of the circle served by the crane and projecting within this circle, so that the material can be readily loaded into cars and run to any place desired.

In point of maintenance and operation this crane is very inexpensive when compared with the usual type of yard crane.

A German Horizontal Boring, Tapping, and Milling Machine

By J. B. Van Brussel

The half-tones show a very heavy horizontal boring, tapping and milling machine, constructed by Messrs. De Fries & Company, of Düsseldorf, Germany. The machine consists of a base plate, the size of which depends on the class of work to be done, to which base the actual bed is bolted. The base is very massive, and is strengthened by a number of ribs which effectually prevent any distortion. The T-slots are machined out of the solid metal. The upright traverses 20 feet on the bed and supports the carriage, which is vertically adjustable to a hight of 9 feet 10 inches on it.

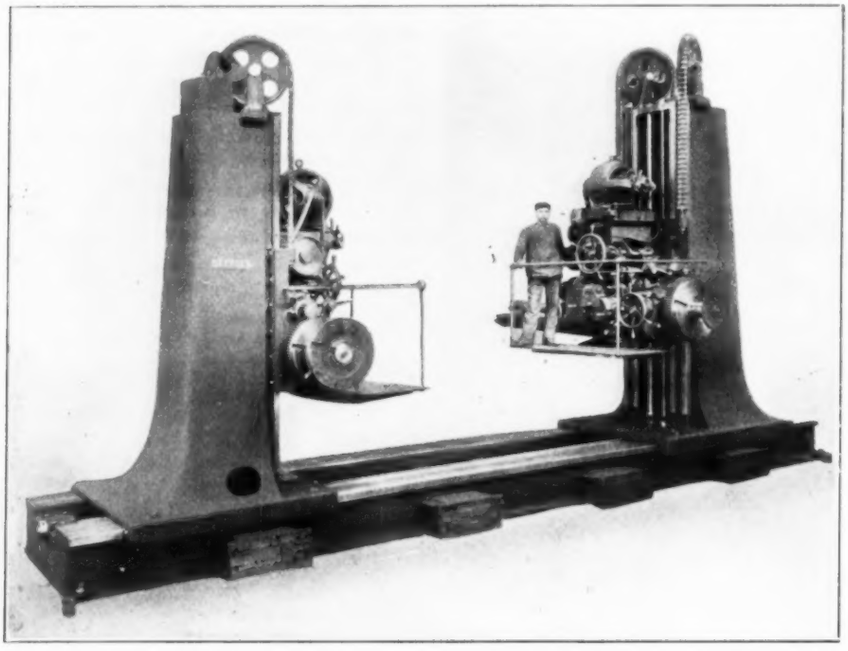


FIG. 1. A HORIZONTAL DRILLING, BORING AND MILLING MACHINE

The carriage is counterbalanced, the weights being placed inside the upright, and it can be inclined 30 degrees either above or below the horizontal. The drive is obtained from a shunt-wound direct-current motor. The drive from the motor to the horizontal shaft of the carriage is by means of a Renold silent chain, the ratio of the drive being 1 to 4.5. From the shaft of the carriage the driver is further transmitted through spur gear to the toothed face plate on the spindle and by means of a pair of spur wheels, to the sleeve which carries the spindle. Back gears are provided in both cases. The boring spindle is of steel 7½ inches diameter ground to size, and has two keyways running the entire length. It is driven by the sleeve in which it slides and there is ample provision for varying the feeds, which are 8 in number from 3.75 to 0.125 inch per revolution. At its front end the spindle is provided with a taper hole for drills, milling cutters, etc., while the rear end runs in a thrust bearing.

When milling, the spindle and the sleeve are locked together and 8 gradations of feed are available, from 0.336 to 10.08 inches per revolution. The front and principal bearing of the sleeve is made of ample size for the work it has to do, and it has a taper and slotted bush for adjusting the spindle, so that the true running of the latter is always insured. A face plate, with T-slots for holding special cutting tools, is attached to the end of the sleeve. All the driving wheels are made either of steel or of phosphor bronze. The adjustment of the large milling cutters, which are attached to the face plates, is facilitated by the bearings of the spindle and the driving shaft, being mounted on a special swivel base, which allows about 10 inches radial movement. The front of the face plate, when as far back as possible, is about 6 inches in front of the base of the upright, and no part of the machine projects beyond it. A variable automatic feed for the boring spindle is obtained by gearing from the sleeve to a horizontal shaft, from which it is taken to the spindle by an arrangement of reversing gear, worm, worm wheel, spur wheels and screw. The spindle can be rotated by hand, and has coarse and fine feeds. The vertical and horizontal milling feeds are also obtained from the horizontal feed shaft by means of suitable gearing, and from the second shaft situated behind the carriages. The carriage and the upright are also provided with quick power traverse motions, which are obtained in a manner similar to that by which the milling feeds are obtained.

The gearing for the vertical and horizontal milling feeds, respectively, consists of two separate trains, so that when curved work is being milled, the horizontal feed can be disengaged, and *vice versa*. The up and down movement of the carriage, as well as the horizontal traverse of the upright, can also be operated by hand. In order to facilitate the management of the machine, a railed platform for the operator is attached to

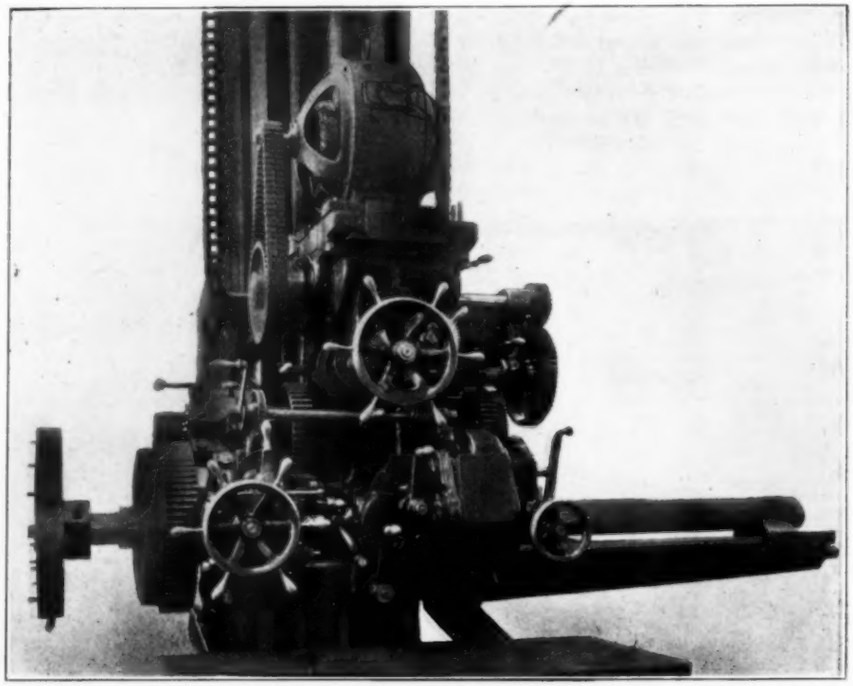


FIG. 2. VIEW OF MECHANISM

the carriage. The arrangement of all levers and hand wheels for the various feeds and quick traverses are also very conveniently arranged, so as to be easily reached and actuated by the attendant from the platform.

The weight of the machine, arranged for motor drive, without motor, but including bed for a traverse of 20 feet, is of 32 tons; one stay 2½ tons; one base plate 20x10 feet, 14½ tons.

A Good Set of Furniture for the Draftsman

By Philip Bellows

Whenever a visitor enters a strange plant he is almost certain to see one department whose equipment is lacking in perfection. If you enter any engineering establishment, whether uptodate or otherwise in its machine shop, you will most certainly find that the furniture of the draftsman is not anything like as good as it ought to be, nor yet as good as it could be made very easily.

No expense is spared to provide the machinist with the most uptodate and expensive tools; boring mills, and milling machines, whose cost runs into hundreds and often into thousands of dollars, are provided to enable the workman to produce his maximum output. On the other hand, the designer, whose duty it is to provide a dozen of these machines with work is given an outfit representing an investment of perhaps $30, and is expected to produce his maximum in quantity and quality. Of course, like the machinist, he provides his own tools or instruments. It is strange that most master mechanics fail to see how they can profitably invest more money upon the stock in trade of their designing force. Yet now and then one does run across such a one, who, for purely business reasons, is willing to do a little better than the average because he recognizes channels of efficiency loss which others are too slow to see and profit by.

In Fig. 1 will be seen a drawing table which came under my notice while visiting recently a large plant in the East. Though not perfect, it goes far toward achieving the practical ideal in a drawing table which I have always looked for in vain in drawing-office equipment.

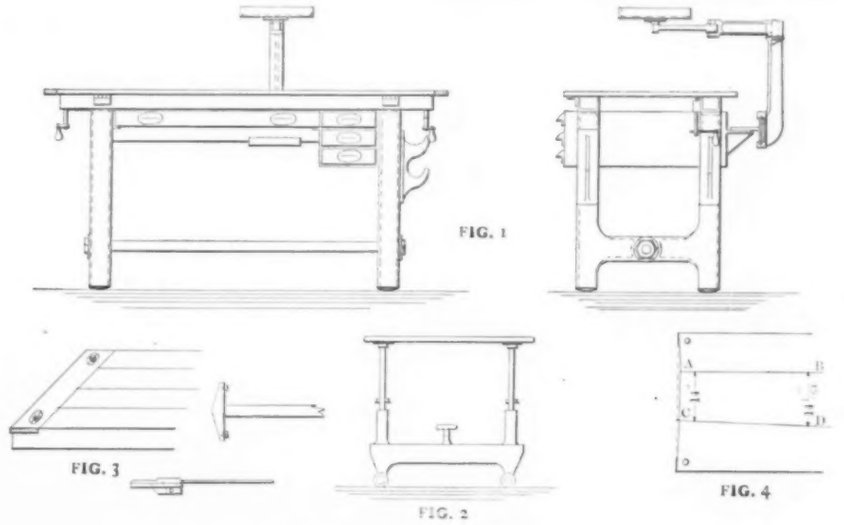


FIG. 1

FIG. 3

FIG. 2

FIG. 4

A GOOD SET OF FURNITURE FOR THE DRAFTSMAN

The Board

The board is a substantial affair 7 feet by 3 feet 6 inches by 1½ inches thick. The ends have cleats rabbeted into the end grain of the board. As was suggested to me by one of the men responsible for its existence, it would have been better to fasten these cleats under the ends with screws set in slotted holes to allow for the shrinking of the wood. When a board has had much use the places where the thumb tacks are used become so pitted and soft that a slight pull on the paper pulls out the thumb tack, necessitating a resetting of the drawing to the draftsman's annoyance. With a board as massive as the one here illustrated, it is entirely possible to pass the face over a buzz planer when in this condition and make a new board out of it.

The T-square

I have often realized the need of such a construction as that shown in Fig. 3, where a steel straight-edge is provided for the butt of the T-square to work against. In this case the latter is provided with two hardened-steel buttons on its working face. With such an instrument really first-class work can be done, mistakes avoided and time saved. Better, perhaps, than steel buttons in the T-square would be two small hardened and ground rollers fitted as shown in the lower small detail, Fig. 3. As a result of the usual practice errors like that shown in Fig. 4 are almost bound to occur, due to unequal shrinkage of the outside and inside boards and also to the wear of the butt of T-square at the middle. Most designers of large experience have had, at some time or other, drawings which have taken weeks, if not months, to complete, and in such a case with the usual equipment it is not unusual to find that a construction line like *A B* will not coincide with the edge of the T-square five and six weeks after it has been made, for the above mentioned reasons, and if a new line as *C D* is required and started at, say, 14 inches below the other and finished with the T-square that made *A B*, it will be found that *B* and *D* are nearly sure to be from 1/64 to 1/32 inch, or more, farther apart than *A* and *C*.

A little reflection shows that if a number of details are built up using *A B* as a basis, and another lot using *C D* as their basis, then someone will get into hot water, usually the designer or the detailer, and yet it is not the fault of either, but the fault of him who can provide the workers with proper machinery and doesn't. Don't wait for some draftsman's supply house to provide you with this equipment. Such places are usually two decades behind times, and you can do the whole thing right in your own shops, then you will be able to see that it is done right.

The Table

Referring once more to Fig. 1, it will be noticed that the legs of the table are of cast iron and are made channel-shaped and reasonably light. A suggestion that might be in place would be to provide these legs with casters, as a slight change in angle is often desirable to get the light just right. The front of the board is hinged and the rear can be elevated by the screws, as shown. The rack at the right-hand side is for blueprints, and is very handy.

The drawers shown are a welcome change from the usual solitary deep drawer (or total absence of any such provision), and give the user a chance to keep his instruments and Kent, Trautwine or Seaton free from a superimposed pile of ink bottles, pencils and instruments. If he needs them in a hurry they can be reached without breaking pencil points and blunting dividers. The frames in which these drawers slide are light castings and make a neat appearance. Perhaps the most valuable single feature of the outfit is the tool tray poised, like a dentist's, close to the work and yet movable to any part of the board. Every designer has known the annoyance caused by having his instruments just over the spot he wants to refer to for one instant, especially if he needs both hands to hold a straight-edge that has just been set ac-

curately to a given angle. This little tray whose pedestal will slide the length of the board can be swung just where it will not be in the way of the worker or his light and yet handy for all the small things he needs.

The Seat

The seat, shown in Fig. 2, is a long step in the right direction. When rightly designed and built it can be made for a reasonable figure and enables the user to move opposite any portion of his work without taking his attention from its details. It is rather elaborate, perhaps, but well worth the investment.

Making the O. K. Tools and Holders

By F. H. C.

The distinctive feature about the O. K. tools is that the points, instead of being made from bar stock and used just as it comes from the mill, are each one forged to shape between dies in a hydraulic press.

Starting with the commercial bar of the proper size, the pieces are cut off in the press shown at the right of Fig. 1, great care being taken to have each piece of uniform weight instead of size. To secure this an accurate balance is placed on a bench behind the operator, a standard forging being in one pan for a weight. The first piece from each new bar is tested and should the weight vary, owing to a slight difference in the size of the bar, the stop in the cutting-off press is adjusted until the weight is just right. This not only saves stock, which is quite an item with high-speed steel but also insures a uniformity in the texture of the forging as the same pressure is exerted in each case. After the cutting off, which is done hot, the pieces go to the forging furnace which is between the presses and in front of the operator in the picture, and from here to the first press with its 50-ton hydraulic pressure. From here it is returned to the furnace, reheated and subjected to 75 tons pressure between the finishing dies, without being allowed to cool. This gives the tools a very good grain as well as insuring uniformity and interchangeability.

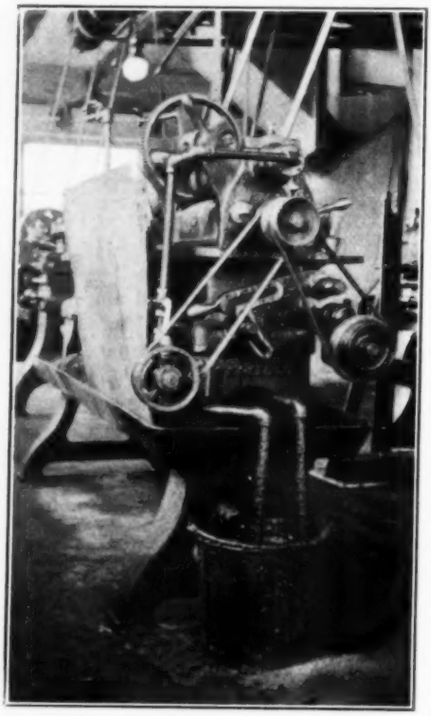


FIG. 2. INDEPENDENT OIL PUMP FOR LATHE

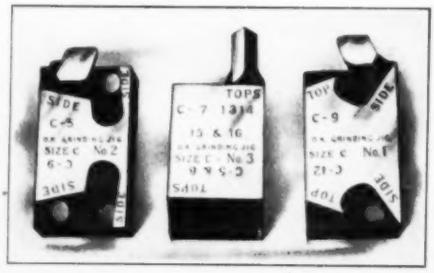


FIG. 4. THE GRINDING JIGS

In connection with the cutting off and forging it is worth while calling attention to the hight of the various tools. The cutting-off press is on stilts, the furnace way up in the air as can be seen, and the forging presses also on wooden blocks. This is not to add beauty or symmetry to the machines or the room but is most convenient for the operator who does not need to stoop a particle for any of the operations.

Lubricating Lathe Work

In order to turn the shanks of the tool points, the forged cutting ends are held in specially formed babbitt jaws which bring the shanks true in the lathe in order to mill them to size. For this and all lathe work, each lathe has a pump and an independent oil system for lubrication. A metal pail at the end of the lathe is the reservoir and from this the oil is pumped directly to the cutting tool through the swinging gas-pipe fixtures shown and is controlled at the work by the regulation gas cock.

Or it can be fed through the hollow spindle of the lathe by opening a plug cock just above the pump, the whole plan being shown in Fig. 2. All the lathes have pans below the bed to catch the oil which drains back into the pail on the floor. These are filled from a barrel of lubricant which is kept well stirred by a propeller near the bottom of the barrel.

The tools now go to the large emery wheels shown in Fig. 3, wheels made up of a heavy steel web with large blocks of abrasive material held on each side and running at about a mile a minute. The tools are held in grinding jigs as shown in Fig. 4, which fit against stops on the grinding rest and give the right angles

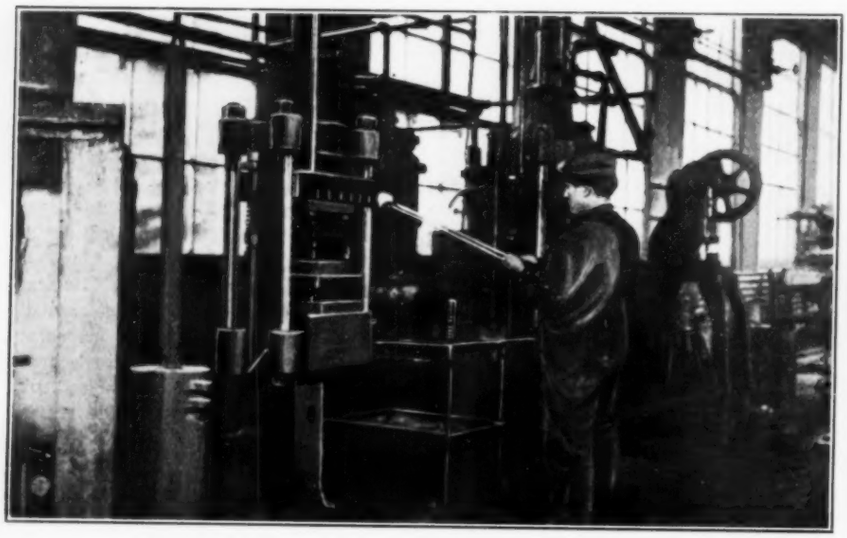


FIG. 1. THE TOOL-FORGING PLANT

FIG. 3. GRINDING THE TOOL POINTS

FIG. 5. CONCRETE SINK AND CLOSET

by simply keeping the jigs in the right position. Similar jigs are supplied customers who desire to maintain the standard shapes.

The building is of reinforced concrete with walls, floor and beams in one solid piece. One of the interesting features is the sinks and closets, as shown in Fig. 5, which are molded in place and are very neat and substantial.

Steel Storage Racks

In order to maintain the fireproof character of the building, steel storage racks have been developed, which are not only simple in construction but capable of carrying great loads as is made necessary by the nature of the work.

An idea of the construction can be had from Figs. 6 and 7, angle- and T-sections forming the supports, which are tied together laterally by threaded rods and distance pieces. Small holes are drilled or punched quite close together so as to allow the shelf slides to be spaced to suit and, as shown, a very large storage space is made available per square foot of floor occupied.

Many of the shelves or racks are naturally of wood to hold the shank of the tools, but metal shelves, in the form of shallow trays, are also used, being made with the edges turned up and corners locked. This gives considerable rigidity to the tray so that it will carry quite a load without breaking.

This factory is located on the bank of the Housatonic river at Shelton, Conn., a spot with much historic interest and only a few miles below where one of the old-time ship yards was located; but today, owing to water powers and the absence of forests, it takes quite a navigator to get a motor boat through without grounding.

The manufacture of an artificial fertilizer whose value has been proved by three years' use on farms in Europe, is reported to have become quite an industry at Niagara Falls. The product is called cyanamide, the principal constituents of which are coke and lime, treated in an electric furnace, the resulting compound being in turn pulverized and combined in a second electric furnace with nitrogen from the air secured by a liquid-air process. When sown this compound decomposes, is absorbed through the roots, and becomes a valuable constituent, and its results as a fertilizer are highly satisfactory, some crops being reported as having been doubled by its use.

While the number of persons killed and injured annually in this country as a result of railroad casualties continues to represent an appalling figure, it is consoling to note that the methods and devices continually being introduced to prevent accidents are bearing fruit, as is evidenced by reports to the Interstate Commerce Commission for the last fiscal year, which show that 3764 people were killed and 68,989 were injured. This is a decrease of 1236 killed and 3297 injured during the previous year.

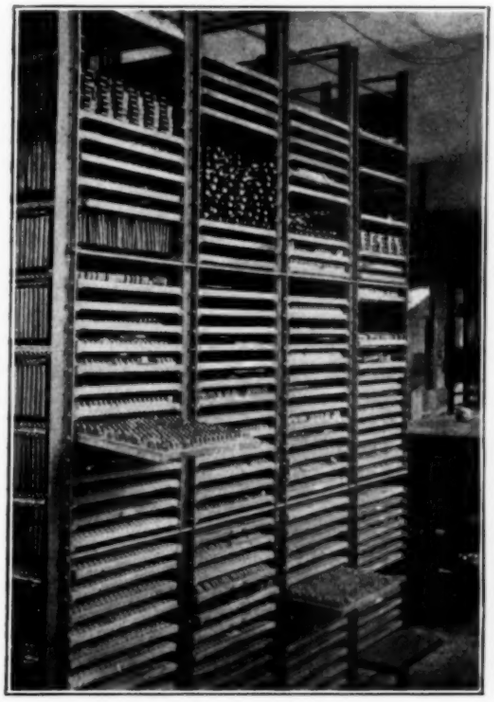


FIG. 6. STEEL STORAGE RACKS FOR TOOLS

FIG. 7. HANDY BENCH WITH SHELVES AND TRAYS

Increasing Production by the Premium System

Fairness, Analyzed Operations, Accurate Limits, An Ample Bonus Based on the Character of the Work Are Essential to Successful System

BY T. A. SPERRY

To anyone who has followed and studied carefully the present-day condition of our machine-shop labor, the imperativeness of some means to speed up and intensify our shop work and methods, and to lessen the time elements of such work, is very apparent. Our best shops are not turning out over three-fourths of their maximum capacity, and many of the others less than half of it. The restriction of output, intentional or unintentional, is almost appalling and is due to a number of causes, foremost among which is lack of proper shop and production organization on the one side, and lack of interest and effort of the shop men on the other. It is the purpose of this article to treat of some of the means of improving this last phase of the problem, through the medium of the premium system of paying labor for added effort.

The antipathy to any such scheme of payment in proportion to the actual amount of work done is well known. This antagonism is not now so open as it once was, but secretly the opposition still exists. Most of these men feel that they are underpaid, and there is a continual tendency to restrict their output to only so much as they feel they are being paid for. There have been many experiments tried to overcome this tendency of the workmen, most of which aim to do so by paying only in proportion to the amount of work actually done; the most common schemes are piece-work and premium and bonus systems.

It is not the intention to discuss here the relative merits of the three systems, but merely to say that the former has been so badly abused as to be most obnoxious and unsatisfactory to workmen, besides failing to give the returns anticipated by the management. Long experience has taught the men that it is unsafe to make more than a certain limited output without danger of having the piece rates cut. The bonus system is not of very general application nor does it in practice give the returns it should. By far the best of the three is the premium system, guaranteeing to the men their day wages and a fair return, in which the management also shares, for their added effort. It is the fairest, the most successful and satisfactory device yet developed toward the coöperation of labor and capital, and when properly applied and conducted will yield returns far in excess of the cost of installation and maintenance. It will do more toward getting full returns from the workmen than will any other method of organization or control.

In the discussion of the premium system for paying labor which is now being carried on so freely in the technical press, there are a few phases of the question which seem to be customarily overlooked or not fully appreciated by both parties to the contract—for it must be regarded as a contract by both workmen and employer. It is generally conceded, in the first place, that the premium system can be successfully and satisfactorily applied to nearly all, if not all, classes and kinds of work, and to nearly all shops or localities of each class, though, naturally, it will be more easily applied and the returns will be more immediate and decisive in some than in others. This is a phase of the question that each individual shop management must look into very carefully for itself, before deciding definitely either to adopt or not to adopt the system. But before deciding adversely many managers, who think the system cannot be applied to their conditions, will do well to consult some thoroughly reliable specialist along this line. In many instances these "hopeless cases" have yielded surprising returns when the system has been applied properly.

Any shop or firm engaged in true manufacturing—as distinguished from building, or in doing repetition work of any kind, in a shop or out of it, can successfully apply this method of wage payment with good results to both employer and employee, if the right spirit is put behind it. For concerns of a jobbing, building or specialty nature, each one must be considered individually and treated according to its own environment and conditions. In any class of work, it may be said as a general statement, the more simple the detail and the more direct the application of the system is made, the more satisfactory and direct the returns will be. A highly specialized shop can, if it wishes, institute a scheme involving a great amount of detail and nicety of adjustment, with more absolute final justice to both parties concerned; but for most situations the simpler the system the better. The average workman cannot readily grasp the intricacies of an elaborate scheme, and the cost of applying and maintaining it is too great for the added returns obtained.

Justice Needed Between Employer and Employee

Another point which cannot be too strongly emphasized is that the success of the system, its very heart and soul, depends on maintaining absolute justice between employer and employee; the latter must be taught to have absolute confidence in the former. This is the crux of the whole scheme. The management must be willing to "play fair;" must guarantee to the workmen that they shall have the benefit of their added efforts; a limit once established must not be reduced without a corresponding change in tools or methods; no limit must be fixed as to the amount a man may earn above his regular day wages, etc. It is on these very points that the piece-work system has fallen into such disrepute and so failed to accomplish its mission. In piece work the gains are all (practically) on the workman's side; with premiums they are mutual.

Few Men Know What a Day's Work Is

Very few workmen indeed, and few foremen or higher officials, realize anywhere near how much work a man is capable of doing in a day; very few of them realize how much time is actually lost or wasted by each or any man in their department every day. They are too busy and hurried to take the time to study these things, even if they are able to, and keep a record of them. It is not what they are in the department for. As long as men keep working steadily, not too excessively long on a job, or their feeds and speeds are not too excessively slow, it's about all the foreman can look after ordinarily. But even when the foremen and executives have, or take, time to watch these phases of the work, very few of them can tell how much a man is capable of doing and should do in a day. Tell an average man who is "working hard" that he can do three, four, or six times as much work in a day as he is doing, and keep it up indefinitely without injury or hardship to himself, and it will precipitate a row at once; yet instances are almost numberless where this has been done repeatedly in nearly all branches of work. Few, even of skilled mechanics, realize either their own capacity or that of their machines, and often this ignorance is so great that it is possible to add a very considerable percentage to their daily output and speed of work without the men knowing it. As an example of this, the case of a certain small shop of about 100 machinists is interesting. The men had all been supplied with new

high-speed steel tools, and the management had tried in many ways to induce them to speed up accordingly; but without success. The men claimed they couldn't do it, and if they were speeded up would soon drop back again to the original speeds, advancing all sorts of reasons and explanations why they did it. As a final resort, without letting the men know anything about it, the driving pulleys on the two big motors which drove the shop tools were gradually increased, 2 inches at a time, from 10 to 20 inches in diameter in about two months' time. Only one man in the shop discovered any difference in the working of his machine, and he only because his planer was on a very insecure foundation and the added speed caused it to shake and chatter.

With these facts before us, and the added one that in a great percentage of cases the piece rates have been and are being set by an "office man" with no real knowledge of the time elements of shop work, and nothing to guide his judgment except the day-work time reports, it is small wonder that piece rates have been commonly set so excessively high. The rates may look small when first set, and lead to some dissatisfaction, but the workman very soon finds through his previously unrealized possibilities of work, that he can quite easily make double or treble his previous wages; the work, however, costs the manufacturer exactly (practically) the same as previously. This does not appear just to him, and his only redress is the inevitable "cut." The story is too old and common to need retelling. After two or three such cuts the workman learns the futility of trying to make large gains for himself and so limits his production to only so much as he has learned he will be paid for without danger of a further hardship and injustice to himself. This is the basis of the so-called "ca-canny" (go easy) policy, even in shops using the piece-work system, and it is where the system has broken down as a means of increasing productions.

It is the fact of tremendous profits to the workmen with no corresponding gain for the manufacturer and no redress for him except in "cutting prices" which has brought piece work into such odium with the working classes. They feel that by each cut they have been robbed and wronged, with no chance of appeal without danger of losing their jobs altogether. So they have no incentive to materially exert themselves and increase their output. If, *per contra*, the piece rates had originally been set at what they were subsequently cut to, the workman would assert, positively and honestly, that he could not do the work for that price, or even for twice the amount—he could not, except by the long training of interested effort—and he would not try to do it.

The Premium System Avoids Common Difficulties

With the premium system, however, when properly applied, these difficulties are largely eliminated, for the gains made in working times are divided between the two parties to the agreement to the advantage of both, but with the greater part of the advantage coming indirectly to the manufacturer: for if, as is customary, the workman is paid for only half the time saved on the operation, the manufacturer gets not only the other half of the wages for the time saved, but he saves also nearly the entire shop burden for all the time saved. If, for example, this burden is 100 per cent. of the wages paid and the workman does a job with a two-hour limit in one hour, the workman gains one-half hour extra pay for one hour's work, but the manufacturer gains the other one-half hour's wages and the 100 per cent. burden for the entire hour saved. His gains by the transaction are nearly three times those of the workmen.

The manufacturer will not save the entire shop burden for the whole time saved by the men in the shop. He will find that his power bill will increase somewhat, as will his maintenance and repairs: the foreman and clerical force will need some strengthening, and most of all the inspection must be watched more closely. He must remember, too, that the increasing of these same forces in his shop, rightly directed, would of themselves result in a somewhat increased output, without the aid of the premium inducement; though experience has demonstrated repeatedly that the added returns in this way are not nearly in proportion to the added expense involved. It must be remembered, also, that the shop that is progressive enough and in earnest enough to install a comprehensive premium system will, by that very fact, tend to speed up its machines and men, and intensify the activities of the shop in general. It cannot, however, get the best results from the men without getting their good will and offering them some adequate inducement to hustle.

Basic Principles of the Premium System

In the installation of a comprehensive premium system many problems will arise, which must be settled by the light of local environment and conditions. There are several basic methods of applying the fundamental principles of premium and which one of these to use in any particular locality must be determined by local conditions. The most common form, which, too, is generally satisfactory and one of the easiest of application, is to give the workman a definite time limit per piece for each operation on each piece or lot of pieces, and to divide with him the time he can save under this limit, as in the illustration given in a previous paragraph. A better arrangement from the manufacturer's standpoint, and one equally as easy and universal in application, is to set the time limits considerably lower than would be used in the former system—a certain definite per cent. lower—and pay workmen no premium until this limit was reached. When the limit is reached, however, pay the workman a liberal premium, say 20 per cent, of his wages (for machine or light work) additional for the entire time he has been on the job. If a workman can still do better than the limit set, divide with him the time he can save on the limit, in addition to the 20 per cent., as in the former case; this divided time is paid for at the day rate only.

This scheme gives the manufacturer the added profit of all efforts made by the workman to reach the limit set in all cases where he does not reach the limit, and yet the prize offered is great enough to induce the workman to strive repeatedly for it until he does reach it. The limits under this system will be set at the best average time that a good man, working faithfully, requires to do the work, so the workman must reach this high efficiency before he gains any benefit from the premium.

An Example

For example, if this best time on a job is 5 hours, under the former method the limit would be set at 7 hours, but under the second method it would be set at 5 hours. When the workman finished the job in 5 hours, under the first method he saved 2 hours and would be paid for one hour extra, or 20 per cent. increase of wages gain for himself. Under the second method he would also be paid the 20 per cent. gain for himself. If, however, the man took 5½ hours for the job, under the first method he would have saved 1½ hours and would be paid a ¼-hour premium or nearly 14 per cent. gain in wages; while under the second method he would have gained nothing and the shop would be ahead the entire gain—all wages and burden—for the 1½ hours saved, and yet the inducement of the 20 per cent. added pay—6 cents per hour for a 30-cent man—is great enough to make the man willing to try the job again until he can do it in 5 hours.

How Much Inducement is Necessary?

One of the first questions which will arise when inaugurating a system of this sort is, how much added inducement is it necessary to offer a man to get his best efforts? The result of years of study and experimenting along this line indicates that a sliding scale, depending on the nature of the work, is necessary; also that a great deal depends on the way in which the case is presented to the men. But for the average, conscientious workman in each class the following seems, in general, sufficient for the purpose: For machinists, carpenters, fitters, etc., 20 per

cent. in addition to their regular wages; laborers, shovelers, masons, etc., where the extra work means proportionally extra physical labor for the men, will require 30 per cent. or 35 per cent. gain; high-speed woodworking tools of dangerous nature, 50 per cent.; furnace men, boiler stokers, cupola men or where the added labor is accompanied by heat, gases or danger, 65 per cent.; and for a few extra hazardous classes, even as high as 100 per cent. additional must be paid for maximum effort. The great majority of our work will, however, come in the 20- to 30 per cent. classes.

Too much care and caution cannot be exercised in the setting of time limits, nor in recording conditions under which, and for which, each limit is set, and the actual work and degree of finish covered by the limit. This is especially true in a shop with a large or changing variety of work or shop conditions. It is the one point over which there will be more misunderstanding and friction with the men than over any other point likely to be involved. Provision must be made and thoroughly and definitely understood that for each and every change in the work, the method, the tools and the shop conditions which affect the work in any particular, a corresponding change of limit will be made. If a more powerful or rapid drive is put on, high-speed, new, or special tools employed, a new jig or fixture made or any means adopted whereby the speed of the work may be increased, the limit must be readjusted to correspond; at the same time the workman must be told why the limit is altered.

Also a variation in the number of pieces given the man will sometimes affect the limit. One of the hardest points to watch and adjust in many shops, and yet a vital point, is to compensate for the gradual general improvement of shop conditions; new foremen, better order, better repair of tools, better system, better light and the thousand little things which every live shop is constantly bettering; no one of these is enough to justify a change of limit, though it does slightly improve the man's working time on each job.

This right of readjustment must not, *per contra*, be abused by assuming changes of condition for the mere purpose of readjusting a limit that is too high, or the workmen will soon lose faith in the entire scheme or in the man at the head of the scheme; then it will fail. The rate setter must keep faith with, and the good will of, the men and convince them of the justice and impartiality of all decisions or readjustments; yet he must not let the men "bluff" him or beat him out of his decisions, or the results cannot be obtained from the system that should be had from it. When this spirit of coöperation can be maintained absolutely, results can be had from the system that are little short of miraculous, but it will take a man of exceptional ability and tact to reach this high standard.

Operations Must Be Analyzed Carefully

Before attempting to establish time limits for work, and especially for work that is to be repeated often and on which the operations and methods are not apt to be changed, it is absolutely essential to decide definitely on standard operations for each class or piece of work, or just what work shall constitute each operation and how each operation shall be done. This must be done carefully and in detail, for it is imperative to success.

In some cases the detail of this description of operation goes so far as to specify the machine, the speeds and feeds, the number of cuts, the kind of tools, etc., to be used. But there are very few shops highly enough specialized to justify or make profitable such minute specifications. After the standard operation is decided upon, it is equally important that the workman does accurately and absolutely just the portion of work allotted for his operation. Standard operations in the shop must precede limit setting. With work of a transient, or occasional nature, the dividing lines of the standard operations will not need to be as closely defined or predetermined, as the likelihood of future misunderstandings with the men, or the value of the record for all its various purposes, is not nearly as great.

In the setting of time limits, an all too common error, fraught with much evil, is the basing of the limits on the day-work time of the workmen. The greater share of premium limits is set in this way, however, and it is one reason for the trouble and dissatisfaction arising in many cases with the premium system. As was previously stated, few workmen realize how much they can actually accomplish, or how much time and energy they regularly lose in a day. Thus when the day-work time is taken as a basis for the premium rate, the manufacturer will some day wake up to a realization of the fact that he has a shop full of excessively high time limits; that he is paying his man excessive premiums that they do not earn. The men will naturally contend that this is their due, as it is by their own efforts that these quicker working times have been established and are being maintained. They do not realize that they got the high limit through deceit—that they were not doing a fair day's work when the limit was established. They will say that "the company gets half of it," when in reality the company has all along been paying more than it should, because of the false standard on which the limit was originally set. The men do not realize either that by the very introduction of system work in a shop, all work in the shop whether premium or not, will be gradually speeded up by the mere force of environment and association, until what was called a day's work before the system was started will be done in from five to eight hours, even though no limit is ever set on that particular piece or operation. This is an unrecognized but real benefit of the system that few people understand.

Methods of Setting Time Limits

There are several reliable ways of establishing correct time limits. One is by the "time study" method, in which the actual time of each element of the operation is obtained by personal observation with a stop watch, of a trained and competent man working faithfully, and all these elemental times added together after elimination of all unnecessary losses, to reduce it to its lowest possible time, and then adding a reasonable allowance for gain. This is a slow and expensive method, but with a keen and fearless observer at the stop watch, with a reasonable amount of practice and knowledge behind him, it will give very good results. It is dangerous, however, to intrust the time observations to an inexperienced man, as it is very easy for a workman to bluff or deceive such a man, and so destroy all the value and reliability of the observations. There are a thousand little ways in which a workman can increase unnecessarily his working time and still seem to be working hard and efficiently. No one knows this better than the workman and most of them are shrewd enough to make use of every one of them when there is a stop watch in the vicinity, whether it is in sight or not. It may be said that the watch should ordinarily be in sight of the workman; he resents being spied upon and distrusts a man who will do it.

Another good way of limit setting is to set aside a room as a "demonstrator's room," filled with adequate machinery, and in charge of a thoroughly good, high-speed machinist and let him determine the best time possible in which the work can be done; then base the limits for this class of pieces on his finding. The machinist must be a good one, must have the best facilities at his disposal, and should not be afraid to consult with the other departments and officers of the company. This is a rather slow, but a very good arrangement and involves practically no added expense, as all of the man's time is on productive work, and the equipment is all standard equipment. The demonstrator would, of course, have to be paid extra good wages, and it would mean the diverting of his work away from the regular line of routine. His room, too, should be separate from the rest of the shop, so that he can work independently of, and undisturbed by, the shop and shop men.

The most satisfactory method, however, is to place the premium and routing department under a thoroughly competent man who has made an intense study of

feeds, speeds, tool steels, machine tools, shop methods and the time elements of doing work; give him all necessary data (in the form of drawings, production orders, etc.) and let him predetermine the proper time limits. Such a man must keep in close touch with the production department, the pattern and forge shops; the tool room and the machine shop; must have freedom to do as he wishes and the authority to insist on his instructions being carried out to the letter. He must be a man with experience enough to know that the limits he gives out are just and fair to all parties, and be able, if necessary, to throw off his coat and demonstrate to a workman that the limit can be made. Such men are not common and will command a good salary wherever they are. This is by far the best method, and especially so for a large shop, or one having a large variety of work going through in small quantities or under varying conditions.

In some shops, limits are decided upon at a conference of the superintendent and department foremen; the conference is held usually after working hours. In one shop, at least one of the shop machinists, selected by the shop men, was also put on this committee with good results. This method is not generally satisfactory, as the men are tired and anxious to get away, and it has the handicap of getting limits set only periodically. Better work can be had at these meetings if supper is served before beginning work.

Guard Against High Limits

But whatever method of limit setting is adopted, guard continually against high limits. Excessive limits are more disastrous and demoralizing than too low ones. There is always redress for a too low limit, but none for one that is too high; nor can too much attention be paid to claims on the part of the men or foremen that a limit is too low. It is a matter of all too common experience that when a limit which has been called too low by workmen and foremen, and which they have failed to "make" after repeated trials, is raised the workman will reduce his time below the original limit on the very next piece or lot. A single concrete case of this, which well illustrates the point, is one where a drill hand had 20 locomotive fireboxes to drill. A time limit of 16 hours each was given. The workman claimed it could not be done, and his working time on the first 16 boxes ranged from 30 hours to 19 hours each. The limit was then raised to 22 hours and on the next two boxes the workman averaged 13½ hours each.

Limits should be set so that a good average man—not an average one, but one a little better than an average—when properly instructed and working to approximately the best of his ability can make continuously for himself the allowance suggested in a previous paragraph.

If, as frequently is the case, the quantities in which certain work goes through the shops vary considerably it is almost essential to establish a "sliding scale" of limits for the work. For example, if a workman has only two pieces of a certain kind to machine, he would be given a certain limit, say, 2 hours each. If on the next lot he has four of these pieces instead of two, he would be given a smaller limit, say, 1½ hours each; or for six pieces he would be given, say, 1¼ hours, or for 10 pieces 1 hour each. This is especially true of planer of miller work, where the work can be "strung on" the machine in quantities, but the rule also holds good on other classes of work, for no man can do the first piece of a lot as quickly as he can do the second; or the second as quickly as the third; it commonly takes him several pieces to reach his pace, and also the lost time in getting ready for and cleaning up after an operation is practically the same for one as for a dozen pieces.

It is generally advisable when the preparatory work for an operation is considerable, as in automatic screw-machine work, in smith or furnace work, or in the alteration of a turret lathe, to consider this preliminary time independently from the job time. It may be advisable to set a separate limit for it, but the ordinary small adjustments of the machine, changing tools, etc., should be considered as a part of the job. This naturally brings up the question of methods of handling tools, jigs, etc., but it is too exhaustive a subject to treat here except to say that all tools and appurtenances should be brought to the man ready for use before he starts the job, so that he need lose no time on this score.

A Closer Inspection Needed

The installation of the premium system will generally necessitate a closer inspection system, and this will result in a better grade of work. In trying to reach a time limit, a workman will naturally not be as careful of little details as he ordinarily would be, unless he knows he will be held up by the inspection department. He must know that all imperfect work on his part will come back to him and be charged up against his premium gains. If this ruling is rigidly enforced the quality of the work done will often be better on premium than on day work, and as an added result of the closer inspection the fitting and assembling work is often materially reduced, with a corresponding saving of time. On large work, the inspector should inspect carefully the work of the first one or two pieces of a lot before they are taken off the machine, and see that the workman thoroughly understands the requirements of the work from the start. On smaller work the first two or three pieces will be inspected as they come from the machine. It may be said here, too, that it is especially necessary to watch the quality of the work of so-called "sharks," who make phenomenal records and "smash the limits all to pieces." This is generally at the expense of quality.

Value of Demonstrators

It will also usually pay to utilize one or more demonstrators in connection with premium work. A good demonstrator will straighten up enough weak points and ragged ends, boost along enough laggards and get enough extra speed and hustle out of the men to many times overpay his wages, and will also help keep the premium man more closely in touch with the work of the shop.

Bonus to Foremen

In some cases a bonus paid to the department foremen will materially strengthen the efficiency of the department. This bonus should be paid in the form of a percentage on the net premium gains made in the department for the week. If the men in the department make a saving of, say, 500 hours and a loss of 150 hours the foreman would be paid a bonus on 350 hours at, say, 2 per cent. of his hourly wage rate. It is necessary to pay for only the net gain in order to keep the foreman after the losing jobs as well as the others. The sympathy and coöperation of foremen must be maintained, and they must strive constantly to improve their department and methods, and must report any change or suggested change to the premium department at once.

The above discussion is general, treating broadly of a few of the salient principles of the premium system and a few of the difficulties of applying them; it refers largely to regular manufacturing establishments, but may be applied in more or less modified forms to jobbing or specialty shops. A later article will deal specifically with the application of the system to, and its workings in, a large combined jobbing and manufacturing plant, in which the difficulties of application are greater and the certainty of returns are less than in a purely manufacturing plant. This article will show definitely the results which have been obtained and which may be expected from it under these conditions.

Reinforced-concrete ties have been in use for several years on the Italian State Railways and, according to the *Engineering News*, the railway administration is said to have placed a contract recently for 300,000 of these ties. The cost is about $1.25 per tie, and the life is said to be three or four times that of the wooden ties. One tie in every thousand will be broken, and investigation made as to the character of the concrete and its bonding with the steel. The manufacturers are also required to guarantee the ties for one year, replacing all those which fail in that time.

Design and Manufacture of Piston Rings

Current French Automobile Practice for Making Eccentric Rings and Methods for Producing a Cam-ground, Theoretically Correct Ring

BY RENE M. PETARD

In reciprocating engines of all types the piston ring is universally admitted to be a part of vital importance; yet, except in elaborate steam-engine construction, it hardly receives all the attention and study it rightly deserves. In a majority of cases it is designed and made according to crude empirical methods. This statement relates mostly to the one-piece split ring, such as is used universally in internal-combustion engines and in a few types of steam engines.

The object of this study is to point out the principles on which a correct piston ring should be based, and to indicate methods of manufacture permitting of a sufficiently close approach to theoretical excellence.

The principal requirement of an accurate and efficient piston ring is that it should bear completely and with even pressure at every point inside the cylinder. The deceptive apparent simplicity of this proposition explains the matter-of-fact way in which many able engineers believe that any round contrivance with some elasticity will answer the purpose. It is evident that, since the metal in the ring has to be under constant tension inside of the cylinder, a shape or a dimension different from that of the cylinder bore will have to characterize the ring when in a state of rest.

In order to obtain pressure around the cylinder wall it was first proposed to make the outside of the ring a circle larger than the cylinder bore, and to provide for the necessary contraction by making the slot of sufficient width. Mathematical consideration of the problem showed that to obtain even pressure against the cylinder at every point of the ring it was necessary to make the ring of gradually decreasing section from the point P, Fig. 1, diametrically opposed to the slot, to the slot itself, S. Theoretically the section should be nil at the point S and the inner shape of the ring should conform closely, although not exactly, to the circle $A\,B$ tangent to the outer circle $L\,E$ at the point S. Such a ring would be a mechanical impossibility. A compromise was struck consequently and a large number of makers still employ rings known as "eccentric" in which the inner face is simply a circle $I\,I$ slightly offset toward the outer face at the point S. Such a construction is no more than a step toward a perfectly satisfactory ring and is fundamentally deficient. Besides giving unequal pressure at the various points of contact it presents the further disadvantage of leaving a considerable passage for the leaking gases between its thinner portion and the bottom of the piston groove, which is concentric with the outer circle, as shown by the circle $G\,G$, in Fig. 1.

To avoid this source of loss the cross-section of a piston ring should be at every point as close a fit in the piston groove as the transverse play of the piston in the cylinder (in case of a trunk piston) and the necessity for freedom of action will permit. A ring can be made answering the apparently conflicting requirements of constant section and uniform pressure if its action is based on suitably graded internal tensions in its metal, instead of being based on the variations of elasticity created by a variation in section. The desired variations in the internal tension, created in the ring by its contraction to fit the bore of the cylinder, can be obtained by making the ring so that its shape in a state of rest will not be a true circle.

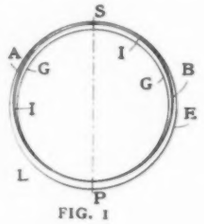


FIG. 1

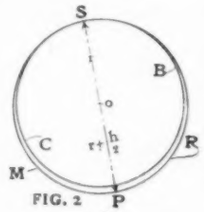


FIG. 2

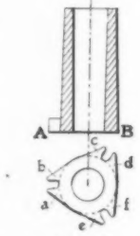


FIG. 3

FIG. 4

DIAGRAMS OF PISTON RINGS AND CASTING FROM WHICH THEY ARE CUT

In construction, such as is shown by Fig. 1, the stiffness is made greater at the point P by making the ring thicker at this point. The same result would be obtained if the radius of the ring at the point P was greater, and the thickness the same; because more bending would be required to cause the ring to fit the cylinder bore. For the same reason at the point S the ring was made thinner, the same reduction in pressure would be obtained if the ring was made of a radius equal to that of the cylinder at this point, requiring practically no bending to adapt itself to the bore, and yet the section at S could be the same as at P.

Thus a uniform-sectioned, perfectly fitting ring to adapt itself to a cylinder bore, such as represented by circle $C\,B$ in Fig. 2, would in a state of rest present an external shape corresponding to the curve $S\,M\,P\,R$, which is not a true circle. This curve is composed of elements of constantly increasing radius. The minimum radius is $O\,S$, corresponding to the slot, and equals r the cylinder bore; the maximum radius is $O\,P$ at the point P diametrically opposite the slot. The value of $O\,P$ should be:

$$O\,P = r + \frac{h}{2},$$

in which h represents the thickness of the ring.

Incidentally it should be mentioned that for the sake of safety in mounting or removing the ring, when it has to be slipped over the full size of the piston, h should not exceed 0.035 of the cylinder bore when the rings are made of a good grade of gray iron.

The value given above for $O\,P$ shows that the thinner the ring the closer its shape in a state of rest will approach that of a perfect circle. It will be noted that the curve $S\,M\,P\,R$ in Fig. 2 is appreciably longer than the development of the cylinder circumference; this has to be made up for by the width of the slot. The slot should be so cut that when the ring is closed to fit in the cylinder its ends will almost meet, save for a clearance of approximately $\frac{1}{100}$ of the cylinder bore, which is ample to allow for expansion at the highest temperatures met in actual work in water-cooled internal-combustion engines.

Having thus determined the proper characteristics of an accurate piston ring, I will proceed to study how it can be produced best.

Manufacture of Piston Rings

Piston rings will best be made out of a mild grade of close-grained gray iron. Care should be exercised in selecting a material softer that that used in the cylinder in which the ring is to work. This will locate the wear on the cheaper part to replace, and slight inaccuracies in ring shape will disappear rapidly after a little running.

The usual practice for rings of small and medium diameter, up to approximately 8 inches, is to cut them out of a casting such as shown by Fig. 3. The surface $A\,B$ is faced on the lathe square

with the general axis of the casting, and it is then used as a foundation to center the blank on the face plate of a turret lathe. Lugs *a b c d e f* are provided to facilitate clamping. Ten to 20 rings, according to size, are rough-turned inside and out and are cut off from the casting. The inside and outside diameter of these ring blanks are generally left 1.03 times larger than their actual measurement on the finished ring contracted to fit the cylinder bore. The upper and lower flat faces of these rings are then ground to finished size, preferably on a horizontal, magnetic-chuck grinding machine. Up to this point the practice is fairly uniform, whatever may be the subsequent process, but in the rest of the sequence of operations a great diversity is found in the methods employed.

I shall describe here the methods most widely used in France in the automobile shops for producing work in quantities.

French Practice for Finishing Piston Rings

The ring blanks, having been treated as indicated in the foregoing paragraphs, have the slot sawed or milled on a length *a b*, Fig. 4, such that, barring a small allowance for grinding, the ring will be of a diameter equal to the cylinder bore when the two ends *a* and *b* are brought in contact. After having been slotted the rings are placed in sets of eight, generally, in the fixture represented by Fig. 5. The internal diameter of this fixture is equal to the cylinder bore plus the allowance for grinding. On a 4-inch ring this allowance amounts to approximately $\frac{3}{100}$; this is necessitated by the fact that in contracting the ring will not preserve a circular shape, and some points will not even touch the wall of the fixture. The fixture is closed by bringing the nut *N* to its seat; the mandrel-like fixture, shown in Fig. 6, is slipped in and the disk *D* centered in the recess *s s*, Fig. 5. The plate *P*, Fig. 6, is then slipped on and the rings are securely pressed between *D* and *P* by the nut *M*. The disks *D* and *P* are a fraction smaller than the bore of the cylinder for which the rings are made. When the rings are securely held in the fixture, Fig. 6, the fixture Fig. 5 is removed and the fixture Fig. 6 is mounted between centers on a grinding machine, which finishes the rings to exact cylinder-bore dimensions. They are then released and slipped into the cylindrical fixture shown in Fig. 7. The bore of this fixture is the exact bore of the engine cylinders; it is mounted on a grinder and the inside of the rings is ground to exact size. Their pressure against the wall of the fixture is sufficient to hold them. The rings are thus finished and ready for use.

Rings made by this method generally fit well in the cylinder and exactly follow its contour; however, they do not give an even pressure. It can be noticed, by inspection of them and of the cylinder wall after a certain amount of use, that they are not equally polished all around their periphery. This indicates that in some points they give an unnecessary pressure, while at others they barely touch but have no contact pressure.

This is well recognized by the makers utilizing this process of manufacture, and to make up for this deficiency they generally make the internal circumference slightly offset in respect to the outside. I have completely considered the theory and results of this policy in the first part of this study.

Methods Used to Produce Theoretically Correct Rings

I will now indicate by what means I have obtained theoretically correct piston rings for 4¼-inch bore automobile engines in Italy. The concern making the engines was a large manufacturer of printing machinery, and possessed some very remarkable and fairly large cam-

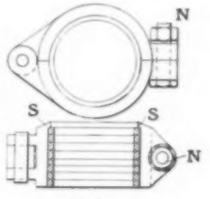


FIG. 5

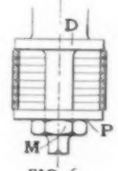


FIG. 6

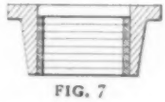


FIG. 7

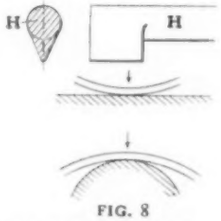


FIG. 8

FIXTURES USED FOR MANUFACTURING PISTON RINGS

reproducing grinders, which were idle a considerable part of the time. The possibility of using them for the manufacture of more correct piston rings than had been the standard up to that time was considered and work started.

A ring blank was selected from a well-seasoned lot and was repeatedly heated and cooled slowly to relieve all internal strains in the metal. It was then turned down to within $\frac{1}{25}$ of an inch of the cylinder-bore dimension. The slot, of the diagonal type, was hand cut with a very fine saw. The ring was then forced open until it took a permanent set at the point *P* (Fig. 2) corresponding to the radius $r + \frac{h}{2}$; a templet had been prepared to verify this. On the contrary, each branch near the slot was very slightly forced inward to decrease the radius at that point. A stout gage having been made of exactly the cylinder bore, the piston ring was slipped in and was found to bear quite satisfactorily. This was not deemed sufficient, however; it could easily have been made right by filing or scraping, but the ring was wanted of strictly constant section. A hammer, such as is represented at *H*, in Fig. 8, was made and the ring exactly fitted to completely and evenly bear in the gage. To increase or decrease the radius of the ring at any point, as was found necessary, it was tapped squarely with the almost sharp edge of the hammer either on the inside or outside as indicated in Fig. 8. Tapping the inside opens the ring; tapping the outside closes it. This, of course, had to be done very carefully; it was done without leaving any hammer marks on the ring surface. When a perfect fit was obtained the ring was subjected to alternate heating to a dull red and slow cooling; this process was kept up for 10 hours to relieve all internal strains which the hammering process might have set up in the metal. After this treatment the fit of the ring in the gage had been slightly altered. Further hammer work and a new heat treatment at last produced a ring which permanently preserved its shape and tension when forced into the gage.

The model ring thus made was of perfectly constant section and gave an absolutely even pressure all around; two master cams were then made for use on the reproducing machines, exactly following the inner and outer profiles of the model ring. The location of the slot in the model was bridged by an arc of a circle in the master cams. The reproducing machines used were of the vertical spindle type.

The ring blanks were prepared in the manner mentioned in the first part of this study and were made true circles of the smallest diameter that could be circumscribed around the model ring. The blanks, finished by a surface grinder on their upper and lower faces, were set in piles of four in a three-jawed chuck in the reproducing machine fitted for internal grinding, and were finished internally. This gave them a true circular outer face, and an inner face corresponding to the shape found in the making of the model ring.

They then went to the reproducing machine fitted up for outside grinding. The setting up was very simple on this tool. A cylindrical steel block had been prepared following externally the internal profile of the rings minus a close fit allowance. This block was vertically mounted in the chuck of the grinder. The rings were simply slipped over it and, as they were internally of an irregular shape corresponding to that of the steel block, they were accurately located and held from turning during the outside grinding.

The next operation was the milling of the slot. For this work a fixture such as is shown in Fig. 9 was prepared. Although the sketch shows circular, the recess *A B C*, in which the blank fitted ex-

actly, was of the same irregular shape as the ring itself. This located the latter and the portion of the blank to be cut away always fell accurately at *M* where the fixture was cut off to clear the cutter. In *S* was a small steel washer with a flat on one side which allowed the blank to slip in and which, when turned around a half turn, securely held it in the position shown by the sketch. This fixture was used in connection with a horizontal spindle milling machine.

Although I now consider it as uselessly expensive for use in high-speed engines, I specified slots such as are shown in Fig. 10 for the rings. The ring being placed in the fixture, Fig. 9, the hatched part *B C D E* was milled out; the ring was then turned around in the fixture and the part *F A H G* was milled out. It will be noticed that both of these cuts are symmetrically disposed in relation to line *C F*, Fig. 11, which corresponds to the axis *M F*, Fig. 9. They were automatically located without moving the fixture on the table. When this milling was done there remained a little bridge of metal between *A* and *B*, Fig. 11; this was easily snapped and filed off by hand. The rings were thus finished and if well seasoned and heat-treated material had been used were perfectly correct in every respect.

It was found preferable to season and heat-treat not the casting from which the

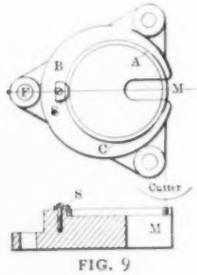


FIG. 9

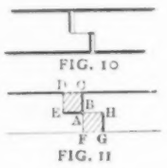


FIG. 10

FIG. 11

FIG. 12

FIG. 13

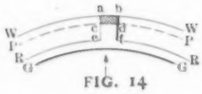


FIG. 14

FIG. 15

DIAGRAM ILLUSTRATING PISTON-RING SLOTS

blanks were cut, but the rough-turned blanks themselves.

Comparison of the Methods

These two methods of making piston rings having been outlined, I will not dwell upon the large variety of other methods proposed or used, as they are numberless. It will be sufficient to point out that the first method indicated gives but approximate results, at the same time it presents the advantage of economy when only limited quantities are to be produced. The second method is much more perfect, but unless large quantities are to be made, or unless cost is almost immaterial, it only pays in shops where there is other work to be done on the reproducing machines. In the case to which I refer, the latter was the case, and no depreciation was charged against the cost of the rings for the use of the machines, as this work hardly occupied them two days in six weeks in a shop where they otherwise were occupied only 60 per cent. of the time. The cost of the rings for the 4¼-inch bore engine considered, was figured out at 3.2 cents a piece, charging the entire cost of making the model ring and tools against the first 5000 rings produced. Each engine took 16 rings and two more were allowed for breakage in assembling.

Before concluding this study it might not be amiss to give a few points of personal experience concerning details of construction and utilization of piston rings.

Piston-ring Slots

In reference to the slot. Three forms of slots are more commonly used, shown in Figs. 10, 12 and 13. Fig. 13 is the cheapest, and Fig. 10 the most expensive to make. A consideration of the conditions, prevailing in engines where trunk pistons are used, will show that the value of these three types of slots is practically the same as far as gas-tightness is concerned. In Figs. 14 and 15 is shown, considerably exaggerated, the disposition of the piston and piston ring in relation to the cylinder wall at any point where the piston does not touch the cylinder. There constantly are such points since the piston is appreciably smaller than the cylinder and is constantly submitted to the alternating lateral thrust of the connecting rod. Curve *W W* represents the cylinder wall, *P P* the piston wall, *R R* the inner face of the piston ring and *G G* the bottom of the piston groove; *a b c f* is the slot in the ring.

It is seen that with the piston bearing on the flat face of the ring a clear opening *a b c d* is offered to the gases. If the ring entirely filled the groove the shape of slots shown in Fig. 10 would be perfectly tight and the other two less so, but such is not the case, as a clearance *R G*, slightly larger than the distance *P W*, has to be provided in order that the piston be allowed to make contact with the cylinder when the connecting-rod thrust will bear in the direction of the arrow. Thus the gases which will have passed the opening *a b c d*, instead of following the slot, will expand in the space between the ring and the piston, no matter what the shape of the slot may be. They will then escape through the space $G_1 R_1 g P_1$ (Fig. 15) under the ring and follow between the piston and the cylinder wall until a new ring is met, when the same process will take place. This shows that as long as a ring has to be slotted the shape of the slot is practically immaterial; the resistance to leakage is only obtained by the constant expansion and contraction required of the leaking gases for their passage through the obstructions resulting from the presence of the rings. If some engines have been known to hold compression for hours, it can only be explained by the fact that capillarity held a film of oil which filled the passages where the gas could have escaped, making the resistance to expansion and contraction so

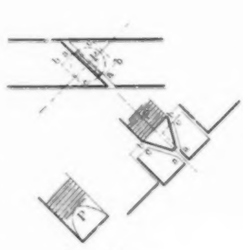


FIG. 16

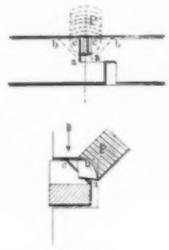


FIG. 17

METHODS OF INSERTING PISTON-RING LOCKING PINS

great that the loss was exceedingly slow.

The above considerations on the theory of leakage past the slot also have an important bearing on the selection of the best position for the slot in the mounting of the engine.

We have seen how leakage takes place when the piston is away from the cylinder wall at the point where the slot is found. If, however, the piston had been in contact with the cylinder wall at that point, there could not have been any leakage. It follows that with two rings in separate grooves, having their slots at diametrically opposed points and in the plane of the connecting-rod play, an engine should be perfectly tight. This shows incidentally that mounting engines with three rings having their slots spaced evenly all around the piston is a mistaken, although common, practice. Such a mounting is less efficient than one embodying but two rings correctly located.

Piston-ring Locking Pins

Since correct locating of the slots is of such importance it has often been considered desirable to provide means for locking the rings in place, as unlocked rings have often been known to turn around in their grooves. The slot itself, obviously, is the proper location for a pin screwed into the piston wall and intended to keep the ring stationary, yet I have seen many instances of rings thoughtlessly weakened by drilling through them at any point of their circumference and merely screwing a pin in the piston. This, besides being the source of many breakages, entirely destroys the laboriously obtained uniform elastic tensions in the ring.

The methods which gave me the best results in automobile work, where the

small size of the rings considerably increases the difficulty, are shown in Figs. 16 and 17. Fig. 16 refers to diagonal slots. Fig. 17 refers to Z-shaped slots. In both cases a soft-steel pin *P* is screwed into the piston wall in the positions shown by the figures, and a small specially prepared cold-chisel used to give the protruding end a wedge shape. The openings *a b c* for the pin heads were filed in the lips of the slots with a fine, Swiss-pattern file. Care should be exercised in proportioning the pin head and in filing the ring to avoid any removal of material which would increase the size of the opening *a b c d* (Fig. 14) uncovered by the piston in its lateral displacements. It should also be noted that in Fig. 17 the gases reacting on the piston in the direction of the arrow, the filing out to make room for the peg was made in the upper face of the ring. Consideration of the effects of gas pressure in the compression and explosion strokes of a gas engine, coupled with those of inertia at high speed, will show that it is at the lower face of the ring that the maximum of efficiency against leakage is required.

The Oxy-Acetylene Torch as a "Putting-on Tool"

By Henry Cave

It has been the custom in most machine shops to play jokes on newcomers to the trade, one of the most popular consisting of sending the greenhorn around the works from one department

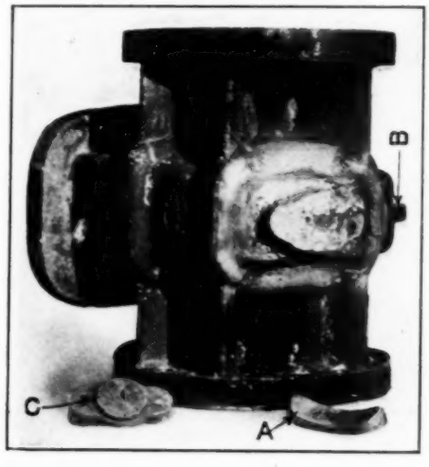


FIG. 1. WELDING ON A BOSS

to another in search of some article, which a little thought would have made him realize did not exist. The two most popular will-o'-the-wisps seem to have been the left-handed monkey wrench and the "putting-on tool." This latter can no longer be used with safety as the rapid development of the oxy-acetylene torch has placed it in a position where it will do the job, and one can readily imagine the guying the joker would get if his victim returned with one of these torches from his supposedly wild-goose chase.

Some idea of the extent to which autogenous welding can be used for this purpose, may be obtained from the illustrations. Fig. 1 shows a 10-inch gate-valve body made from a steel casting, which, after being machined up, was found by the Chapmen Valve Company, of Indian Orchard, to be short of a boss. The steel foundry had failed to make use of the loose piece on the pattern provided for this purpose. As it was necessary to find some way out of the difficulty, the problem was solved by sending the castings to the Autogenous Welding Equipment Company, Springfield, Mass., which uses and is agent for the Davis-Bournonville process.

They had the steel forging, shown at *A*, Fig. 1, made so as to form as large a part of the boss as possible. The flame of the oxy-acetylene torch is very small, the tip used for this purpose giving a welding flame that is only about three-eighths of an inch long and one-quarter of an inch in diameter. It is, therefore,

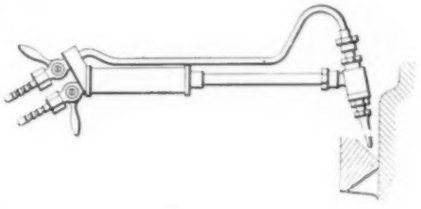


FIG. 2. POSITION OF TORCH AND SHAPE OF BOSS WHEN WELDING

necessary that the flame should come in contact with every drop of metal welded, it not being possible to make a lap weld. Thus it was necessary to make the forging *A* V-shaped, so that it would form a groove when placed against the wall of the casting to allow the flame to reach to the center, as is shown in Fig. 2. It was first of all necessary to cut off a lug corresponding to the one shown at *B*, with the cutting torch. This lug was put on the pattern for the purpose of locating the loose piece which is shown at *C*. The forging was then held in position and the torch applied, metal being added from low-carbon steel wire to fill up the groove and build up the required shape.

The boss was then faced up and showed good sound metal. It can be readily realized from this job what a boon this equipment will prove to the machine shop, as everyone knows the uncertainty of obtaining sound steel castings and all these defects can be satisfactorily taken care of with the oxy-acetylene torch. This enables steel castings to be used where formerly it was necessary to use manganese bronze or steel forgings. The cutting process also enables the steel founder to trim off the risers more satisfactorily than with a saw.

One of the principal features of this process is the accurate work that can be carried out, it being possible to line up the broken pieces of parts that are accurately machined, so that they come very close to their original positions. This is

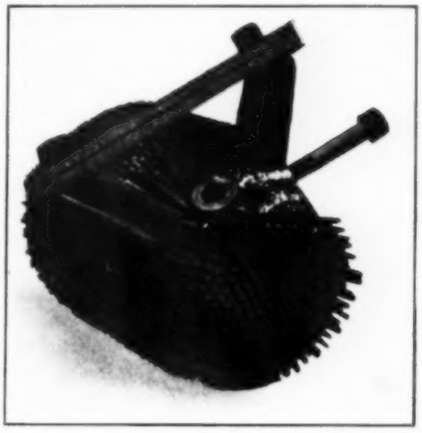


FIG. 3. ARM WELDED ON

clearly shown in Fig. 3, in which an air-cooled automobile cylinder is shown with a broken supporting arm welded back on. A straight-edge resting on the machined feet shows the perfect alinement obtained. Another interesting feature is the fact that, though the fracture passes through the hole into which the bolt is screwed, after welding the bolt was screwed into place without even running a tap into the hole, the fit being all that could be desired. This cylinder is, of course, cast iron, but practically all metals can be readily welded by this process, though the cutting is confined to wrought iron, steel and steel castings.

Tapping Stay Bolt Holes in a Marine Boiler

By G. C. R.

We had some work on a marine boiler which included the tapping of the inner and outer sheets for stay bolts. The sheets were 10 inches apart. The tap was 1⅝ inches diameter, 18 inches long, and was fluted the full length.

It was used in an air machine, but we found that after it started to cut the inside sheet it still kept cutting the outside one. So much so in fact that the stay bolts would almost drop in place. We then made a new tap, but fluted it for only 9 inches from the end. The front end we fitted with a tit or guide 10 inches long and the size of the drilled hole. After tapping the outside plate and entering the end of the tap in the inside one the part of the tap which was in the inside plate was without flutes so it could not cut large.

A Few Locomotive Repair Kinks

By Ethan Viall

There are dozens of devices, many being very complicated, for rotating the drive wheels of a locomotive while setting the valves, but the simplest, lightest, as well as most efficient apparatus is, I believe, the one made by E. J. Buckbee, machine foreman of the Urbana shops of the Big Four railway at Urbana, Ill. Most of the devices in use work from the center of the pit, and are not only heavy and awkward to put in place, but are sluggish in motion.

Fig. 1 shows the rollers upon which the wheels are raised from the rails and rotated. A similar device is placed under the wheel opposite to the one shown, and the wheels are raised by screwing up the nuts on the long bolts connecting the roller boxes which slide on top of the rail.

An inspection of the way this part of the device is made will show that it can be taken apart, after the nuts are loosened, by simply lifting up the different pieces, thus enabling one man to take off or set up the rollers without having to employ a crane, jackscrews, crowbars and four or five men, as in some places.

The mechanism used to drive the rollers and through them the wheel, is also extremely simple and is the only one I have seen working from the outside. A worm, driven by a standard reversible air motor, meshes into a worm gear, the spindle of which is connected to the roller axle by a semi-universal joint and the whole thing substantially mounted on an iron plate—and there you are!

A Neat Blacksmith Shop

As a rule the blacksmith shop is the dirtiest place about a railroad shop, or any other shop for that matter, so I was considerably surprised at the unusual neatness and order of the one here, nor had it been cleaned up simply for inspection as one could easily see. The foreman, Thomas McDonough, likes order, and to know where things can be found after they have been used, and Fig. 2 shows the rack he has had made for the spring swages or formers. The frame-

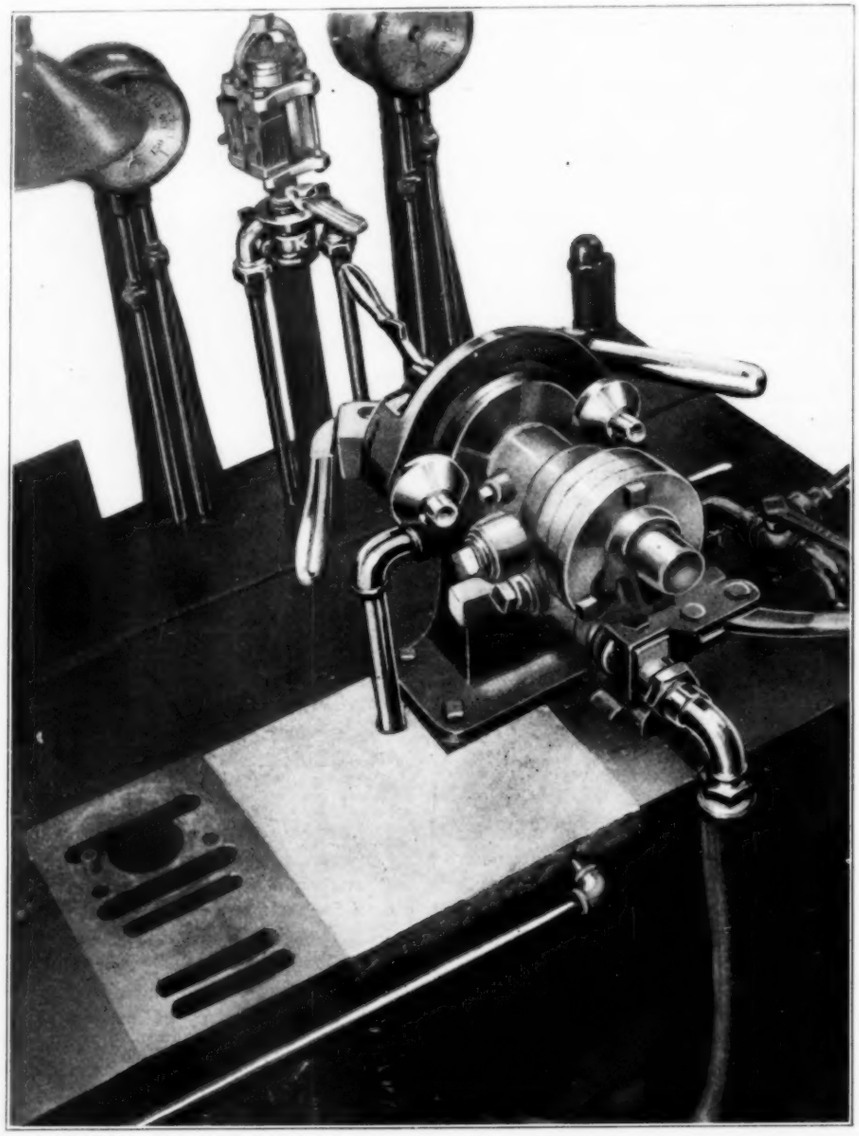


FIG. 3. TESTING AIR-BRAKE VALVES

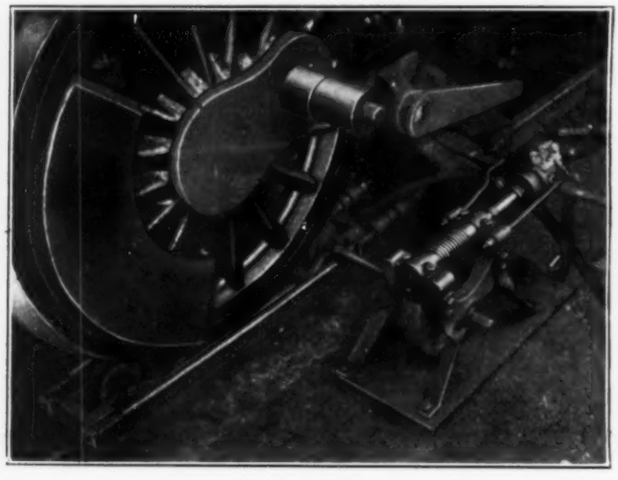


FIG. 1. PNEUMATIC LOCOMOTIVE VALVE SETTER

FIG. 2. A NEAT BLACKSMITH SHOP

work is made of heavy iron and the pins are of ¾-inch iron.

In making spring swages, he prefers making them with a semi-loop, as shown

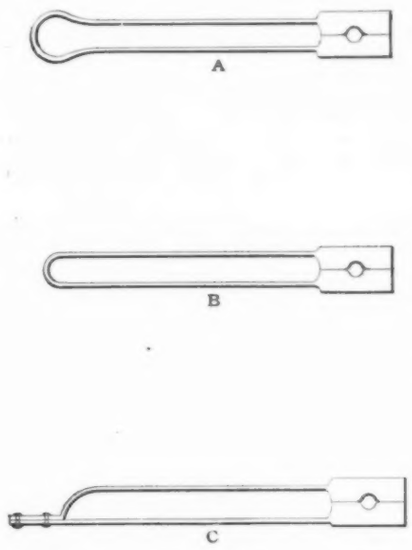


FIG. 4. THREE WAYS OF MAKING SWAGES

by the chalked one in front, and all swages made since he took charge of the blacksmiths have been made that way.

MAKING SPRING SWAGES

Fig. 4 shows three ways of making spring swages, both *A* and *B* being incorrect, and are too liable to spring or twist out of shape even when a guide pin is used. *C* is the more general form in uptodate shops, the ends being held together by two rivets, as shown, though sometimes one rivet and a band is used. However, all things considered, Mr. McDonough thinks the kind with the semi-loop shown in Fig. 2 preferable, as it has all of the accuracy and reliability of *C* combined with the springiness of *A* and

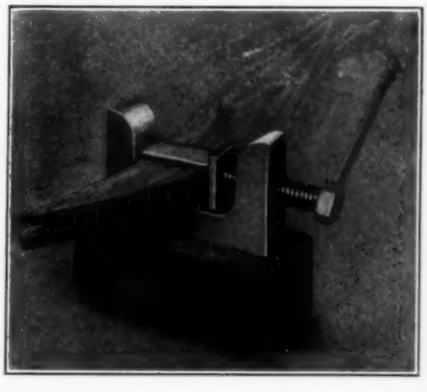


FIG. 5. CLAMPING WHEEL SPRINGS

B. This springiness is of especial advantage, as it lifts from the work better. A heavy clamp used to compress locomotive springs is shown in Fig. 5.

TESTING AND CUTTING FLUES

The device used in the boiler shop for testing flues is shown in Fig. 6. The flue is held between two valves that admit cold water at 100 pounds pressure and any leak is at once detected. The end of the machine nearest the front is adjustable for different lengths of flues by means of a pin fitting into holes in the bed. A plunger set into this adjustable head, automatically clamps the flues as the air is turned on to force in the water. This tester is just as effective and is not so sloppy as the kind in which the flue is immersed in water and filled with air alone, the leak being detected by the bubbles.

After the flue is tested, it is released and slightly tilted to drain off the water, which runs into the trough and out into a pipe. On the right of this cut is shown the flue cutter. This is of the ordinary rotary type, the flue being laid on a set of rollers with one end against a stop and the other end under the rotary cutter which is lowered by a hand wheel.

TESTING AIR-BRAKE VALVES

A very simple form of valve-testing machine is shown in Fig. 3. All the clamping is done by eccentric levers, making the quickest possible lock. The two rear levers draw in headed pins, while the front one clamps by pushing out the end of piece *A*, which is pivoted at the middle. Air is turned into the valve at about 85 pounds.

The slotted iron block set into the bench at the left is used to set the valve bodies in when adjusting the plugs or other parts. Crosshead pins wear out so much faster than the other parts that unless some way can be devised to replace the pins, the entire piece must be scrapped.

REVERSING CROSSHEAD PINS

Fig. 7 shows the method used by Gen-

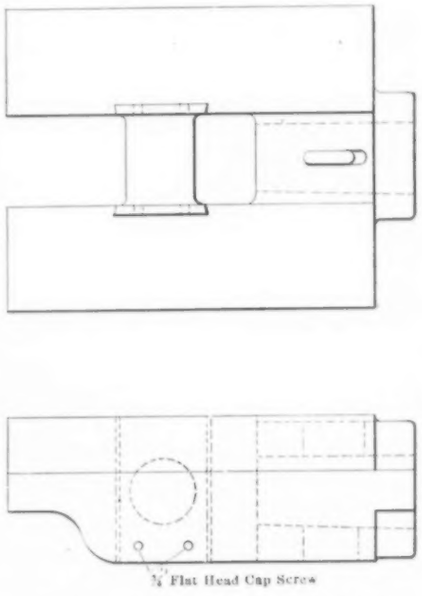


FIG. 7. RENEWING CROSSHEAD PINS

eral Foreman A. F. Bradford. The old pins are cut and a new one dovetailed in, as shown, and forced home at 15 or 20 tons pressure. The result is a crosshead practically as good as new.

For the pictures and information in this article I am under obligations to Master Mechanic J. A. Gibson, who did everything in his power to show me the interesting things.

FIG. 6. TESTING AND CUTTING FLUES

Some Antique Machine Tools
Number 5

By E. A. Dixie

Fig. 19 shows a cutting-off machine. This is a very old machine, at least 75 years I should imagine. The rear end of the spindle, which is hollow, has four set screws for centering work and the front end has a chuck of ancient design mounted on it. This chuck is unique, the jaws are independent and the screws which actuate the jaws are rather difficult of access with the wrench. The rim of the chuck is rounded, like a hand wheel, to be used, in conjunction with the operator's hand, as a brake. Owing to the shape of the head there is no room for a cone pulley, but another casting on top carries the cone and spindle, and motion is transmitted from the cone spindle to the head spindle through gears of equal size. The lathe was, of course, intended for work of small diameter only so that back gearing was not considered necessary.

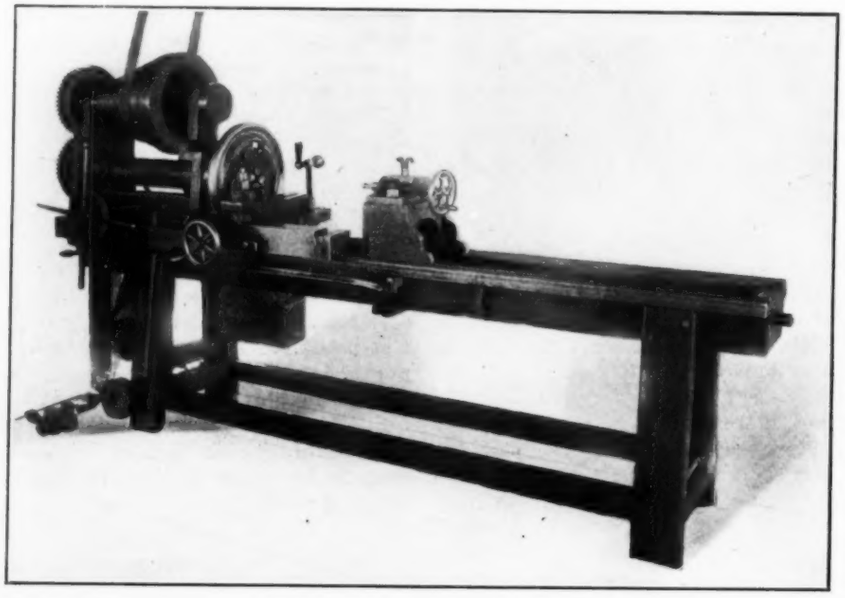


FIG. 19. A CUTTING-OFF MACHINE

The pilot wheel in front of the head is on a shaft having a pinion engaging with a gear on a shaft carrying a sprocket wheel engaging with a chain between the shears. The two ends of the chain are secured to the carriage, the loop at the head end passing over the sprocket just referred to while the loop at the other end passes over an idler mounted in a yoke. This yoke has a threaded shank so that the chain can be adjusted; the end of the shank with washers and nuts is seen at the extreme right on the end of the bed.

A belt from the small end of the cone pulley drives a small shaft at the back and a cone on this shaft connects with a cone below the head which through worm and gears drives the pulley in front of the front leg below the head. A belt from this pulley drives the pulley mounted on the same shaft as the pilot wheel.

It will be noticed that there is a capstan head on the cone-pulley shaft. This is used in connection with a tommy bar when screwing couplings onto shafts, and was formerly used when cutting threads of large diameter with a die, as the power of the machine was not sufficient for this work.

Between the cross-feed handle and the pilot wheel is shown a threaded shaft with a flange on it. This is an adjustable micrometer(?) stop for the carriage. It consists of a rectangular nut, secured to the base of the head, which has a four-thread screw in it about 1¼ inches diameter by 18 inches long. A set screw is provided for clamping the screw when set to correct position. The flange on the end of the screw comes in contact with the carriages and acts as a stop. This is the oldest adjustable carriage stop I have so far seen.

The carriage is of the old weighted rise-and-fall design with very limited cross-feed motion, a T-slot being provided; the tool block is shifted each time the limit of the cross-feed is reached, the cross-slide, of course, being returned to extreme position before the tool block is shifted.

The reversal of the feed on this machine is the same as on many of the Silver lathes; it is shown in Fig. 20. The shaft *A* is driven by belt from the machine; on it is mounted the spur gear *D* meshing with the spur gear *C* on the shaft *B*. A left-hand worm *F* is keyed to the shaft *A* and a right-hand worm *E* to the shaft *B*. Between these two worms *E* and *F* is the worm wheel *G*, which through the shaft *H* and other mechanism actuates the carriage. The shafts *A* and *B* are so spaced that the worm gear *G* can be either disengaged with both worms or engaged with either of them by raising or lowering it slightly. It is easily seen that when the worm wheel *G* is in engagement with *E* it rotates in one direction, and when in engagement with *F* it rotates in the opposite direction. In most cases this reversing arrangement is placed under the head of the machine.

Fig. 21 shows a 72-inch by 12-ft. engine

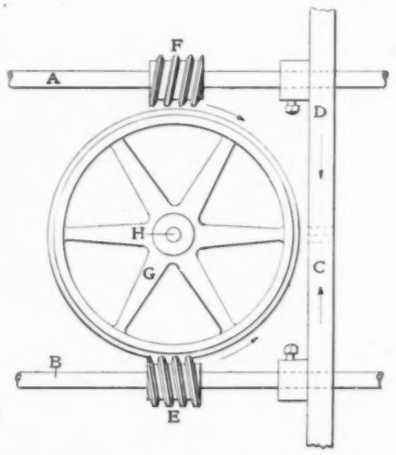


FIG. 20. REVERSING MECHANISM FOR THE LATHE FEED

lathe, known in the shop as "Redmond's lathe," because for many years an old man named Redmond ran it. The back gearing is under the head, and triple gear or face-plate drive, if you prefer it, is obtained by throwing the belt off the cone pulley and putting a pinion on the shaft carrying the tight and loose pulleys with the curly arms in front of the head. The carriage is actuated by hand or power along the bed by a rack fastened to the carriage. When the carriage is in the position shown, near the head, the rack sticks through a hole in the wall and projects into the next room. The carriage is of peculiar construction, the slide rides on two V's in front. The rest is provided with a weight to hold it down. T-slots are provided at various places on the tool rest for the tool posts of which there are two. The head of the tool rest can be

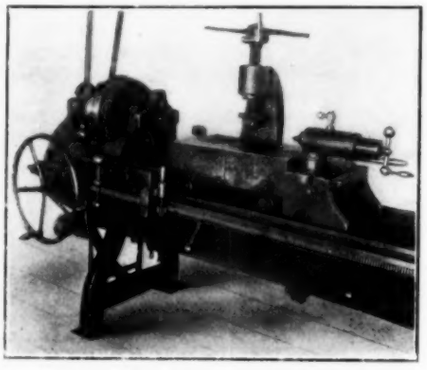


FIG. 22. THE SHAFTING LATHE

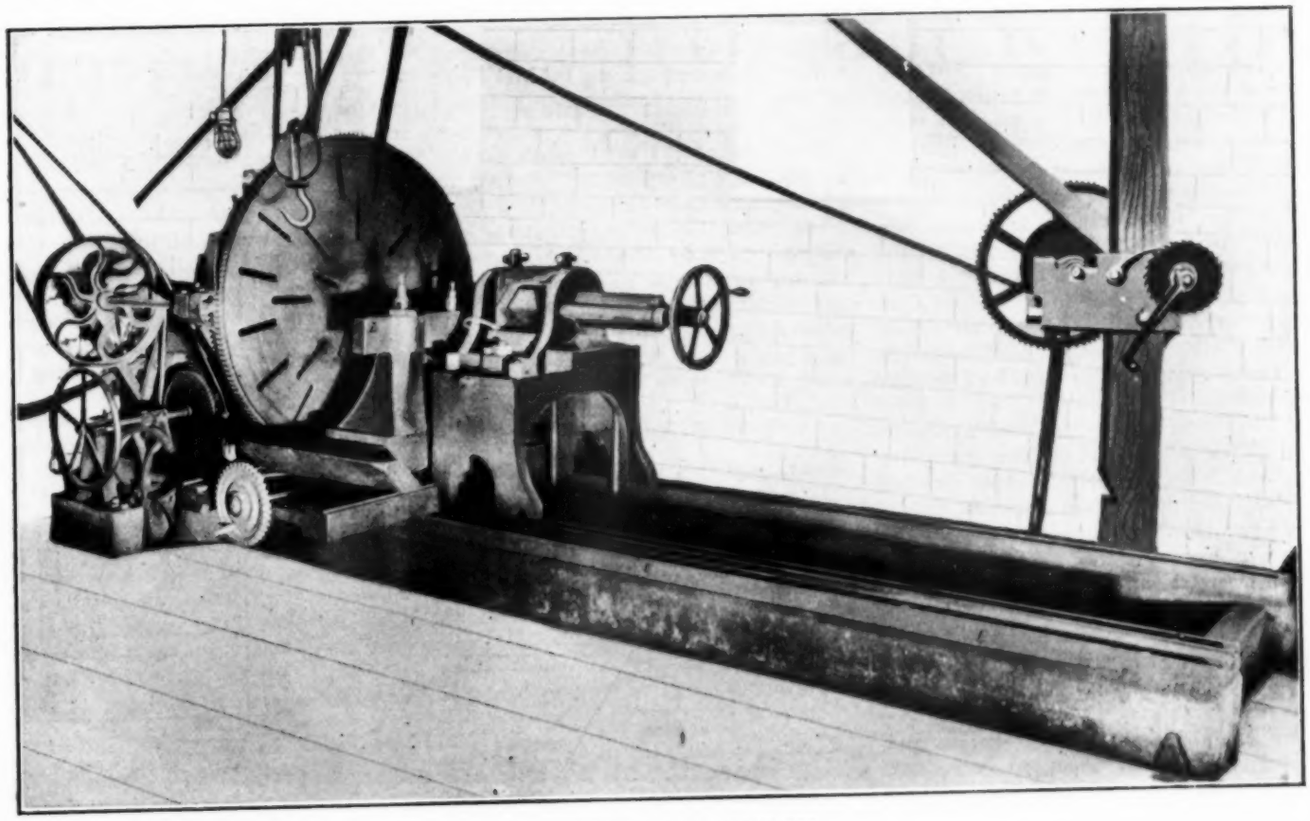


FIG. 21. LATHE WITH STONE BED

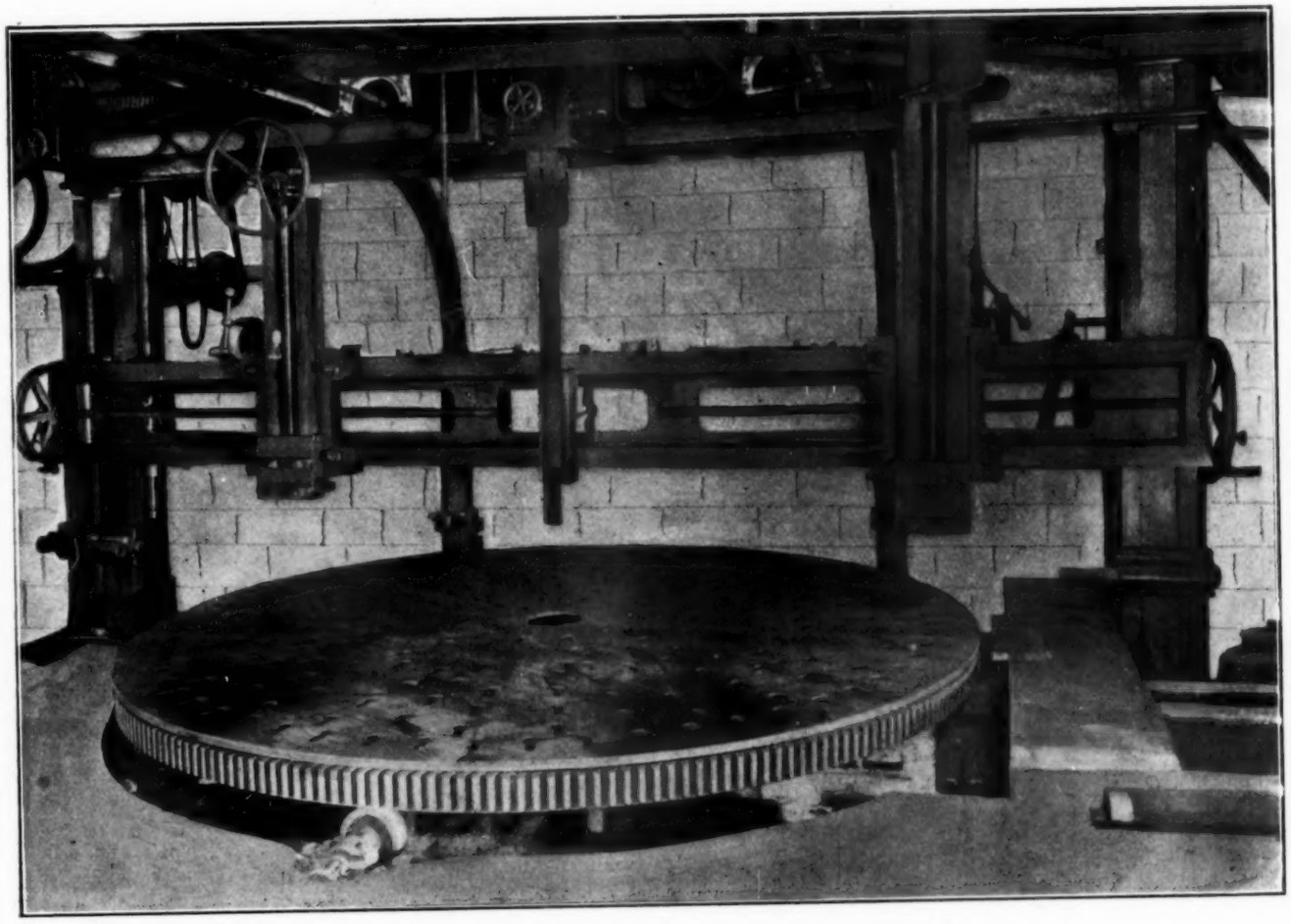


FIG. 23. BORING, TURNING AND SPLINING MILL 70 YEARS OLD

swung to any angle for either facing or turning.

The tail spindle is square. The tailstock can be set over for turning tapers. The bed of this lathe is made of stone with iron strips fastened to it. Formerly there was an automatic cross-feed but it is absent now.

Fig. 22 shows a lathe known as "the shafting lathe." It is used now for straightening. The feed is by chain. Helical gearing is used in the head. The rack in front with face set vertical is rather odd. The large hand wheel in front of the head is for hand feed through the chain.

The power feed is the same as shown in Fig. 20, except that the two spur gears *C* and *D* have been replaced by sprocket wheels and the two are connected with a chain, which, of course, necessitates the use of worms of the same hand. The ball levers shown in front of the bed are fastened to a shaft which controls the raising and lowering of the gear *G*, Fig. 20, so that the changing of feed direction from any point along the bed is not quite as new as many people suppose.

Fig. 23 shows a vertical boring and turning mill built about 70 years ago. The table is about 12 feet diameter supported on rollers and spur driven. Between the housings the mill will swing about 16 feet.

The machine is equipped with two boring and turning heads and in the center at the top there is a reciprocating square bar, with a stroke of 3 feet, to which splining bars can be fitted so that pulleys, etc., can be turned, bored and keyseated at one setting. This tool is used on large jobs to this day and does satisfactory work.

A Column Facing Rig

By L. W. G.

We have made many hundred columns with top flanges, as shown in Fig. 3. The flange is provided with two finishing strips upon which the head of a machine fits. We tried a face mill in the milling machine, but it was too slow; then we put them in the shaper with better success. Shaping the face took about 15 minutes, including the handling in and out of the machine, but the setting up was something of a job. Another objection to using the shaper was found in the fact that the shaper was on a different floor from the drilling machines, where most of the other work was done, which meant a good deal of handling.

We finally ventured to try a facing cutter that can be mounted in the drilling machine and fed straight down onto the work. The great difficulty was to provide a steady bearing for the leader, without which we could not hope to succeed, as neither the casting nor the machine could be expected to withstand the lateral strains set up in starting the cut on such a rough surface as these pieces present without getting the cutter jammed, or breaking off the flange.

The cutter, Fig. 1, consists of the machinery-steel disk *A*, which carries four high-speed steel tools *a*, mounted in slots, and secured by means of fillister-machine screws, as shown. A taper shank *B*, having a flange, is fitted to the cutter disk *A* by means of a parallel extension, which in turn supports the spherical-ended leader *C*, as shown in Fig. 1. A flange is provided on the leader similar to the one on the taper shank and between these the cutter disk is clamped by means of the four screws *b*, which also serve as drivers. We put as few tools in as we could in order to reduce the feed pressure as much as possible, which in a cutter of this kind may become very great owing to the dulling of the edges on the sand and scale.

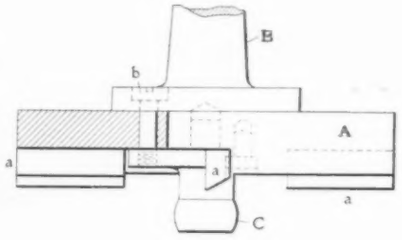
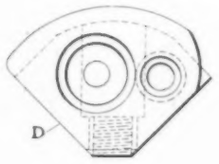


FIG. 1



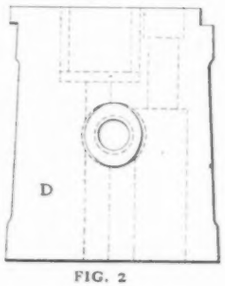
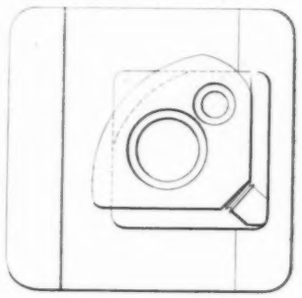


FIG. 2



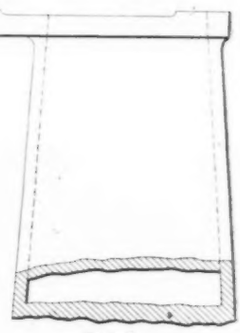
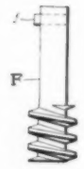
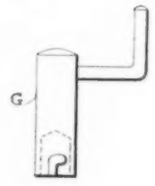
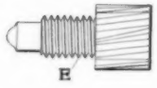


FIG. 3







A COLUMN FACING RIG

A machinery-steel block *D*, Fig. 2, of rectangular prismoidal form, with its sides at the same angle as the core of the casting, is furnished with a hardened-steel bush to receive the leader *C* of the cutter, and is arranged to clamp very firmly when in position by means of the round-pointed screw *E*, which is made in one piece with the worm wheel, as shown. A worm *F*, arranged to engage with the worm wheel *E* is operated by means of the socket wrench *G*, the bayonet joint shown fitting over the pin *f* in the shank of the worm *F*.

A flange on the block *D* is provided to engage the surface of the casting to facilitate getting it into position, the flange being small enough to clear the inside of the cutters *a*, Fig. 1. The crank handle of the socket wrench *G* allows very rapid handling of the clamping screw, and the bayonet joint being hooked in the direction opposite to that of rotation while loosening, allows it to be used as a handle to lift by.

This rig has proved very successful, as it has not only saved considerable time in handling, but the time of the operation has been reduced from 15 minutes to four.

Practical Letters from Our Readers

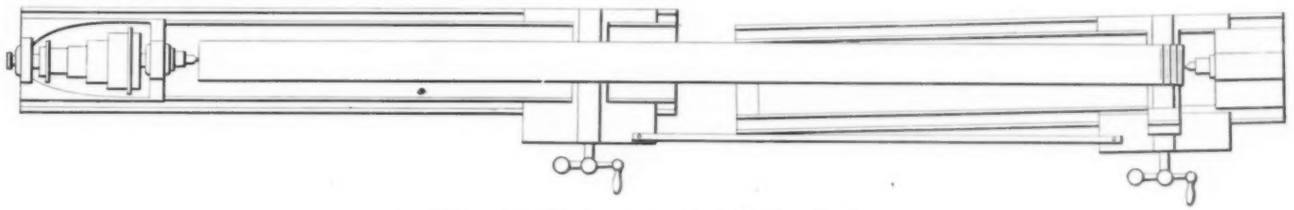
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Cutting and Threading a Long 8-inch Pipe

I lately had a piece of double-thick 8-inch stem pipe to recut the threads and make new flange couplings. The length of the pipe was 19 feet 2 inches, and the longest lathe in town would take only 16 feet between centers, and there was no pipe cutter that would cut larger than 6 inches. First I bored and threaded the flanges in the lathe, using the taper attachment setting it over for the standard pipe taper of ¾ inch to 1 foot; then I took two lathes that were near together, raising the driving lathe 1⅜ inches to bring the centers about level, then removing the tailstock. I took the headstock off the other lathe, giving me room to swing the piece of pipe holding one end in a chuck, the other on a pipe center. I lined up the driving lathe true with both centers, swinging the second lathe around enough to turn the required taper, as shown, thus making a taper attachment of the second lathe. With this arrangement I was able to make a good job.

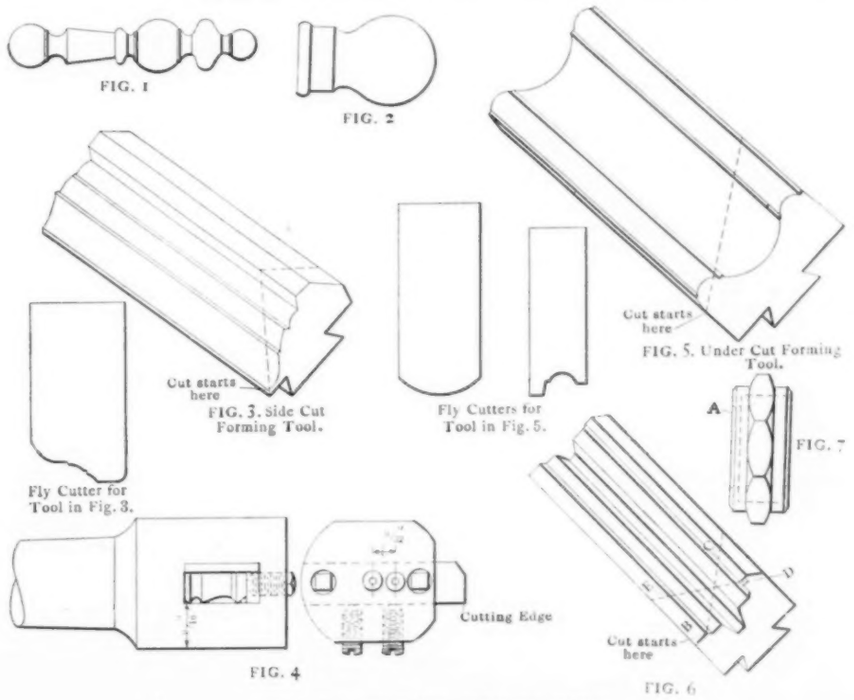
Portsmouth, N. H. W. H. K.



CUTTING AND THREADING A LONG 8-INCH PIPE

Side- and Under-cut Forming Tools

These tools as used in the manufacture of plumbers' supplies, steam goods, etc., can be made in an unlimited number of shapes. The illustrations show some pieces turned; also three of these tools showing one for side-cut and two for under-cut turning, as made by me while working as a toolmaker in a large brass goods factory. Formerly these tools were made in the shop on the shaper with shaping tools, with the result that they were poorly finished and would have to be filed for several hours in the vise. This filing operation was a costly one, the tool marks frequently being deep and full of chatters, with the result that when the tool was finished its form would be most anything but what was aimed at in the beginning. Tools made this way did poor work, requiring a great deal of polishing, with the result that shoulders that ought to have been square were almost entirely buffed away to get the tool marks out. By the use of fly cutters in a slotted eccentric head fitted to the milling-machine spindle, I have been able to make the tools much cheaper and with a very fine, smooth surface. This has given such a smooth surface to the turned work that it requires very little buffing to give it a high-class finish.



SIDE AND UNDERCUT FORMING TOOLS

Fig. 1 shows a very irregular shaped piece of brass. The tool for this piece was milled with 3 fly cutters. The tool for Fig. 2 was milled with one fly cutter; and side-cut tool, Fig. 3 was milled with one fly cutter as shown. Time required to finish this tool, which is 7 inches long, including milling the dovetail on the bottom complete ready for hardening was four hours; time required to finish the fly cutter for this, 40 minutes. The fly cutter is able to duplicate this tool a great many times as it is sharpened by grinding on the face like a formed milling cutter. There is not clearance on these fly cutters except where they cut on the side when a clearance of 2 degrees is given. The cutter head, Fig. 4 makes it possible to use the cutters this way where if the tool was planed in the shaper one would have to be very particular and give the right amount of clearance to the shaping tool in the start.

To make one of these forming tools a sample piece is turned. It is then taken to the toolmaker, who cuts it in half. This is then laid on the face of the fly cutter blank and the form is scribed. It is then milled or filed to the form as marked. The form is also marked on the end of the tool blank which is put on the milling machine and roughed out by the ordinary milling cutters to be found in the tool room. The head Fig. 4, hold-

ing the fly cutter is then placed in the milling machine and the form milled on the tool blank. I never use a file on these tools after they are milled with the fly cutter but polish with fine emery cloth.

To obtain the cutting edge on the forming tool cut off the end of the tool on an angle of 40 degrees as shown by dotted line on tools in Figs. 3, 5 and 6. In a forming tool as shown in Fig. 6 for turning the shoulders, sides of squares, face or side and chamfer on edge of both shoulders of the nut Fig. 7, it is necessary to have the cut start as shown by dotted line *B* to *C*. The tool will then finish the face or side of the nut last at *C*. This will prevent the tool from leaving a bur on the edge of the finished hole at *A*, Fig. 7. In the event of the work not having a finished hole the tool may have its cut start at *D* and finish at *E*.

A great number of nuts are made at this shop and long experience has proved this to be a very satisfactory way of turning these nuts or other pieces that have a finished hole as shown at *A* Fig. 7.

Edwardsville, Ill. J. H. BLAIR.

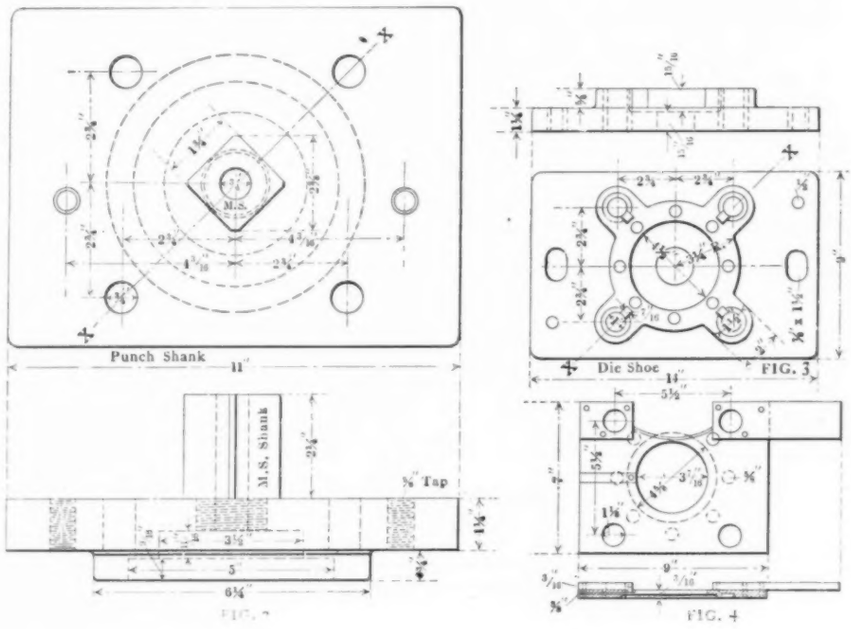
A Compound Die

The die shown in the sketches is a good example of an arrangement for blanking and drawing at one operation in a single-acting press. The piece to be made with the die shown is a circular cup 2¾ inches diameter by ½ inch deep, having six recesses radiating from a boss in the center. The depth of the recesses is about 5/32 inch; the stock used is 0.025 inch thick.

The complete die is seen in Fig. 1. It is here shown in section (on dotted lines *X X*, Figs. 2 and 3) at the extreme point of the down stroke of the press. The die is of the subpress type with automatic knockout for the punch, and automatic ejector for the die. The reason for having the ejector for both punch and die is because you cannot depend on which place the work will stick. The knockout for the punch is worked from the ram on the up stroke by the automatic knockout which is a part of the modern press. The lower ejector is worked also by the up stroke from the guide pins by a crosshead which connects to the central forming die. A brief description of details follows:

Fig. 2 is the punch block made of cast iron, with a machine-steel shank. Fig. 3 is the die shoe, also of cast iron. Fig. 4 shows the stripper plate and guide for the strip stock. This plate is made of machine steel and will be referred to later.

In Fig. 1 all parts are lettered and are shown in detail with corresponding letters. *A* is the blanking die; *B* is the punch as well as the drawing die; *C* is the lower forming punch; *D* is the drawing punch as well as the recess-forming die; *E* and *G* are spider and ring forming the automatic stripper to strip the drawing punch *D*; *H* is the plunger connecting stripper *E G* to the mechanism of the press.



PUNCH AND DIE BLOCKS AND STRIPPER

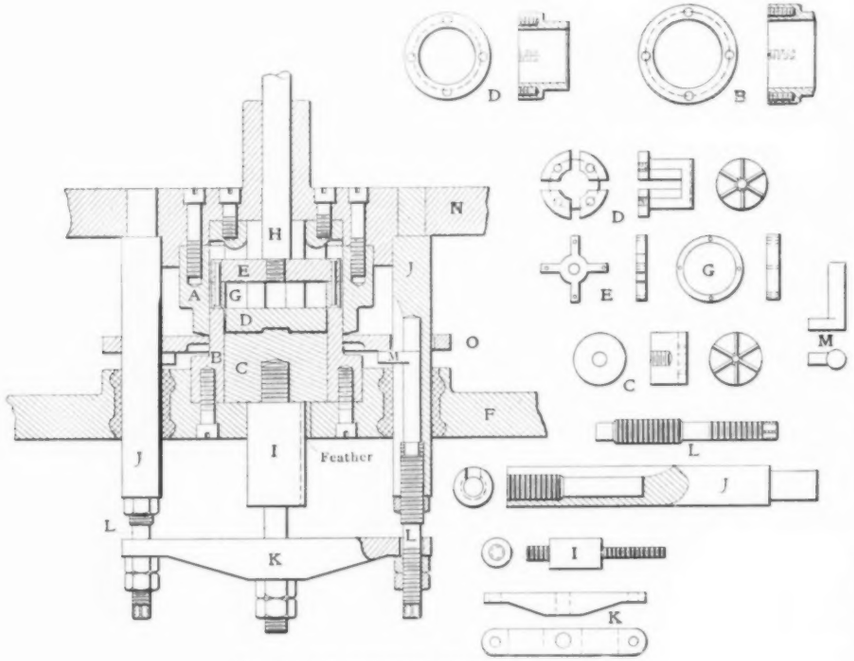


FIG. 1. DIE CONSTRUCTION AND DETAILS

The forming punch *C* ejects from die *B*, being forced up by plunger *I*, which is connected with the guide pins *J* by the crosshead *K*. The stock is stripped from die *B* by stripper *O*, which is shown in detail in Fig. 4. This stripper plate is held up normally by seven coil springs around the die *B* countersunk into the shoe *F*, the opposite ends of the springs being sunk into the stripper plate, as shown in Fig. 4. This plate is held from rising too far by two small studs (not shown), which are diagonally opposite each other and fastened to shoe *F*.

They are adjusted so that the plate stands about 1/16 inch above the die *B*. At the down stroke of the press the stock has to go down about 11/16 inch, the coil springs compressing and letting the plate descend. As the ram goes up, these springs cannot strip the stock as they are light, being made of about No. 25 music wire. The four lugs *M*, extending from guide pins *J* make the stripping action positive. In the drawing, Fig. 1, these lugs are shown resting directly under the plate. This position is not as it actually should be; the lugs should be about ⅞ inch below, as the stroke of the press

which the die was intended for was 1½ inches. The error in the drawing is corrected in the detail.

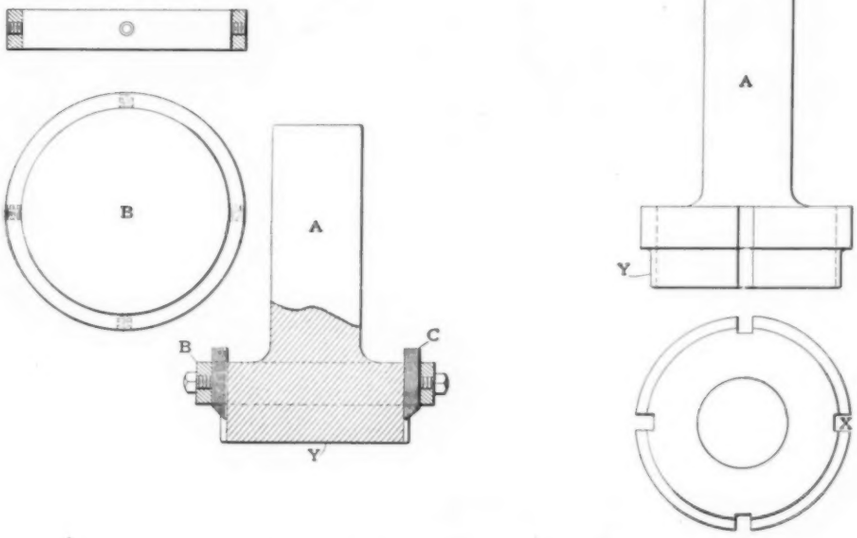
In making such a die all turned parts should be hardened and ground. The die illustrated is in actual operation every day, and produces about 12,000 pieces per day of 10 hours.

Grand Rapids, Mich. F. C. MASON.

A Counterbore for Large Holes

The counterbore shown herewith was designed especially for beveling the end of the bore in automobile cylinders. We have used the same idea for counterboring straight holes, however, and it works equally well.

The holder *A* and the retaining ring *B* are made of machine steel. The tool *C* is ⅜-inch square tool steel. The holder is slotted at *X* to receive the tool, and



COUNTERBORE FOR BEVELING CYLINDERS

the end is turned to any required size to answer as a pilot. This pilot end *Y* should be case-hardened. The retaining ring has four set screws coming opposite the tools to hold them securely in place. If the tool is required to give a fine finish a larger number of tools may be inserted.

Washington, D. C. R. B. LOVEJOY.

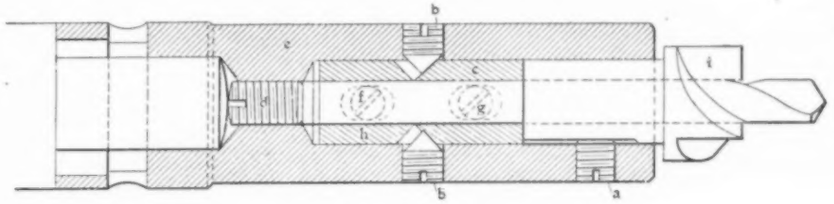
Chuck for Drill and Facing Tool

In designing some special machinery it was found necessary to make a chuck that would hold a drill and facing tool and which would give a sensitive adjustment to both drill and facing tool. The facing tool must begin facing as soon as the drill is through the hole and must finish to 0.001-inch limit.

The advantages claimed for this chuck are simplicity of operation and low cost of construction. The facing tool has a straight shank with a flat side, engaged by a flat-end set screw *a* and is adjusted by cone-point set screws, *b b* which engage bushing *c* behind the facing tool. The drill is of the straight-shank variety which also has a flat to prevent rotation and is adjusted by a flat-end set screw *d* in the back of the chuck.

The body of the chuck *e* is of machine steel and is held to the spindle by a bayonet-catch; it is tapped for screws *a*, *b*, *d*, *f* and *g*, and has a straight hole to receive bushing *h* and facing tool *i*. Bushing *h* is of machine steel, casehardened, is slotted for screws *f* and *g* and countersunk to fit cone-point set screws *b b*. These screws are set a little in advance of the countersunk spots, so that when they are screwed down, the bushing will advance and adjust the facing tool.

The drill is kept from rotating by *f* and *g*. It is obvious that screws *a*, *f* and *g* must be loosened before adjustments can be made. S. T. EDGER.

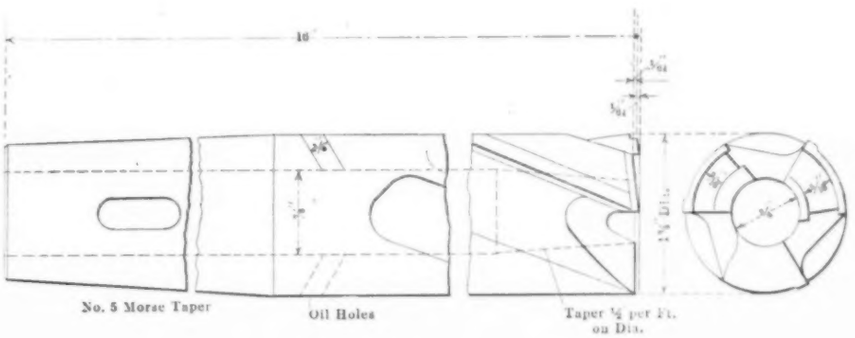


CHUCK FOR DRILL AND FACING TOOL

Core Drill for Test-pieces from Steel Castings

Test pieces were required about ¾ inch diameter by 8 inches long, to be taken from the center of nickel-steel castings that were from 2 to 4 feet thick and up to 5 feet diameter, these having to stand high centrifugal strains after a great deal of machine work had been done. In most cases we would drill from 4 to 10 inches deep with regular drills and then start the core drill. We had considerable trouble in getting a drill to stand up and also trouble in getting rid of the cuttings. A number of different shape drills were made with poor results, and the job was dreaded by the shop and tool room. I designed and had made the drill shown which proved very successful.

As illustrated, it was made with a No. 5 Morse taper shank without the tang, as the hole went through it, but had a key slot to match a similar one in the drill spindle which we used on all heavy tools and sockets to prevent them dropping or working out. In deep holes a socket, of course, was used. The tool should have plenty of clearance at the center and also at the cutting edge on the inside, as indicated in the sketch; about the same clearance on the outside as a twist drill, also three spiral flutes of liberal size to carry up the cuttings. Oil is fed to the center by the holes shown. The principal nov-



CORE DRILL FOR TEST PIECES

elty is the cutting edge which, as shown, breaks the chip up into sections so it has plenty of room to get away. Each of the three cutting faces is set 1/64 inch ahead of the one following, so the 3/16 one cuts 1/64 inch deep before the 5/16-inch one cuts, and that 1/64 inch deep and the 3/16-inch one 1/32 inch deep before the wide cutter cuts and makes two narrow chips. This drill also works well on a horizontal machine. In starting the core drill on a surface a piece of plate with a hole to fit the outside of the drill should be clamped on until the drill gets a start. The cores were broken off by driving in wedges.

In making the drills, they were turned up and bored and reannealed, an arbor made to fit at both ends of the bore, then the flutes and clearance were milled and notched between the faces on the end, as shown, and the faces backed off like a formed cutter by putting on a collar and mounting in the steady rest, the lead screw being geared to the right pitch for clearance and compound rest used; they were then hardened and ground. They were sharpened many times on the faces of the flutes, and then can be annealed and the teeth worked over several times as the sizes can vary.

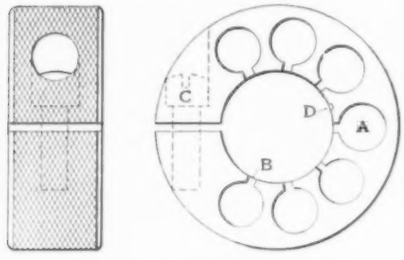
Pittsburg, Penn. THOMAS A. DICKS.

A Lap Holder

The sketch shows a lap holder which is an improvement over the solid holder with the adjusting screws, inasmuch as the lap is pressed onto the work with practically an even pressure all the way around.

The holder is made of spring steel, the holes *A* drilled through and sawed through at *B* into the center hole. The laps are made up of suitable diameter to slip easily into the holder when it is opened up.

The adjusting is done by a fine-pitch screw *C* and in the largest sizes is easily turned by a screwdriver, enabling minute adjustments to be made with certainty.



A LAP HOLDER

These holders are made from 2½ inches down to 1 inch outside diameter, and hold laps from 1¼ inches diameter down to ½ inch.

A small key in the lap fits into the keyway *D* in the lapholder and prevents the lap from turning when in use.

Berkeley, Cal. W. L. WEBSTER.

Drilling Flue Flanges

For drilling flue flanges on boiler heads similar to the one shown in Fig. 1, Edward Dinwiddie, of the Decatur Novelty Works, made the drilling device shown in Fig. 2, a bottom view of which is shown in Fig. 3.

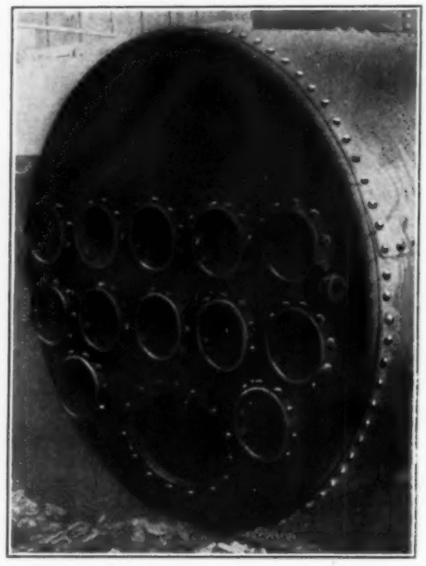


FIG. 1. THE FLUES TO BE DRILLED

As the cut shows, the flanges were drilled from the inside, the drill being fed in by the screw *A*, Fig. 3. There were 10 holes to be drilled in each flange, so 10 pins were set an equal distance apart around the outside rim of the drilling device and a flat piece of iron was clamped onto an angle plate in such a way as to act as an index stop for these pins. Set screws were also placed in the rim, as shown in Fig. 2, to adjust it for drilling the holes the right hight in the flange.

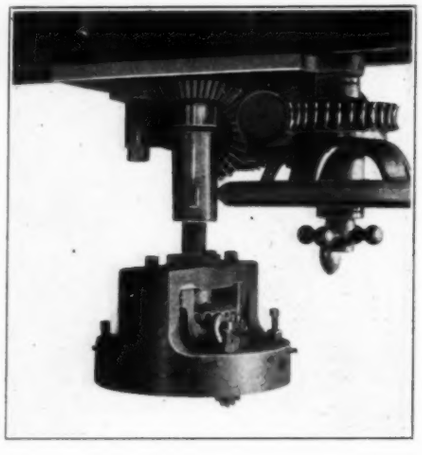


FIG. 2. THE FIXTURE IN THE MACHINE

Decatur, Ill ETHAN VIALL.

A Safety Trip for a Punch Press

The cut shows a device designed to prevent accidents on the punch press. It was gotten up after two of the operators had each lost a hand. The superintendent's instructions to me were to make it foolproof. "Make it so that it cannot be operated without using both hands and one foot, and the only thing the operator can get under the punch will be his head." It was a large Bliss press, and the work to be done was about 16 inches long. We removed the treadle bar which was part of the press, and bent a piece of steel ½ inch thick and 2 inches wide to the shape *D*, to go between the legs at the back of the press, to which it was hinged. The front end of this new treadle bar comes even with the front of the press. On this is attached the footboard *E*, which is locked at the bottom by the two levers *A A*, which are fastened to the front of the press *F* and held in position by the helical spring *C*. The new treadle is held up by means of the helical spring *J*. It will be seen that you cannot push down the treadle until both handles are pushed toward each other.

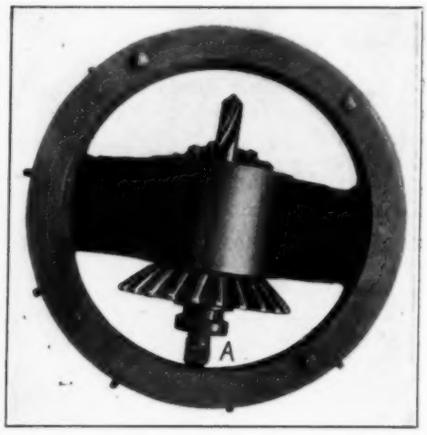
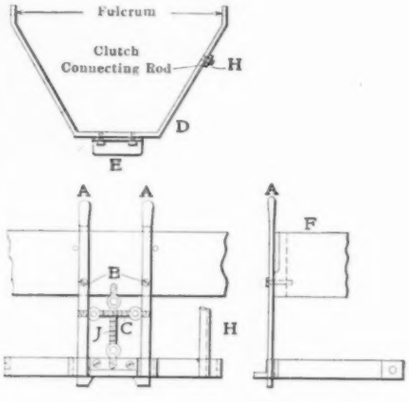


FIG. 3. BOTTOM VIEW OF FIXTURE

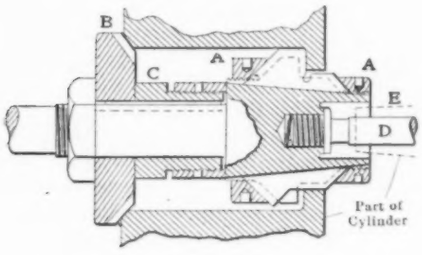


A SAFETY TRIP FOR A PUNCH PRESS

Bethel, Vt. A. HENRY MATSON.

Cutter for Gasolene Engine Valve Boxes and Covers

The cutter head shown was designed for boring out valve boxes and facing the top of the cylinders where the valve covers are held down. It has 12 teeth, and each alternate tooth is cutting differently, as will be seen on the drawing. It will be seen that blades can be adjusted by the nuts *A*, and so as to bring the milling cutter *B* in correct relation again the adjustable distance piece *C* is altered. The shank *D* fits in the valve-stem hole



CUTTER FOR VALVE BOXES AND COVERS OF GASOLENE ENGINES

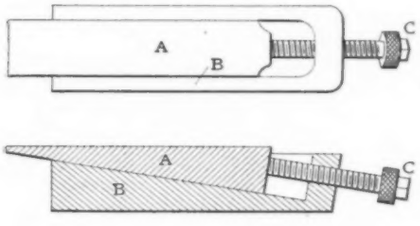
E to steady the cutter. The cutter is held in a drilling-machine spindle and one is used as roughing cutter and one as the finishing cutter.

This cutter has given great satisfaction and reduced the cost of machining. I have not drawn all the parts out separately as I think the drawing is sufficiently clear for anyone to understand. The body is made of mild steel, cutters of tool steel, the guiding shank of tool steel hardened and ground, and the nuts and adjustable distance piece of mild steel case-hardened.

Birmingham, Eng. T. A. J.

An Adjustable Wedge for Use on the Machine Table

I send you a sketch of an adjustable wedge which I use quite extensively in my



AN ADJUSTABLE WEDGE

shop in Ivrea, Italy, in connection with milling-, shaping- and planing-machine tables.

The tool is a wedge *A* which slides in a hollow block *B*, under the pressure of a screw *C* having a portion of its head nurled for a finger grip, and the rest made square or hexagonal to fit a wrench.

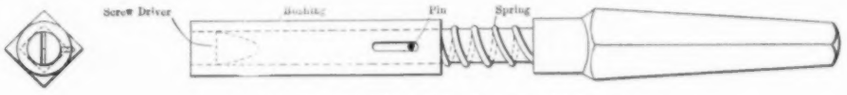
A plurality of wedges having different thicknesses can be used on the same blocks for obtaining a wider range.

The tool has proved very useful not only for setting pieces on the table of a machine, but also for clamping and holding irregular shapes on vises.

Ivrea, Italy. C. OLIVETTI.

A Screwdriver for Headless Set Screws

In a large textile machinery plant where there are thousands of headless set screws used they have a screwdriver like the



A SCREWDRIVER FOR HEADLESS SET SCREWS

cut. Anyone who has ever had a quantity of screws to put in will appreciate the fact that with this screwdriver it is not necessary to hold the fingers at the end of the screwdriver to prevent the same from slipping out of the slot. It also sets each screw to a determined depth, according to the location of the pin.

About twenty ¼x¾-inch screws can be run in flush with the casting in one minute with this device.

Lowell, Mass. R. H. VICTORY.

Adjustable Supports for Jigs

Being interested in the articles on jig design that have from time to time appeared, I believe the details of some practical movable stops for use in jigs and fixtures may be of interest. These are used in shops where I have been employed.

When springs are not used, a pin is fastened in the upper hole in the point shown in Fig. 1 and in Fig. 2. In Fig. 1 the long hole is sometimes drilled concentric with the outside of the stock. Some foremen in the factory where the sliding point, shown in Fig. 3, was a favorite, made use of the small 3/16 tit screw, shown, to prevent the members from being lost. When this was done the cut in the bottom of the special shapes, shown at the upper left in Fig. 3, was not made. The round on the upper one of these two special points is seen to be at right-angles to that on the lower.

While the nurled-head screw, shown in Fig. 4, has been used without a stop screw, it is not advisable to do this, particularly on milling fixtures, where the vibration might easily loosen it. These last two types are used principally for heavy cuts, there being, of course, no chance of their slipping.

GEORGE R. RICHARDS.

Brooklyn, N. Y.

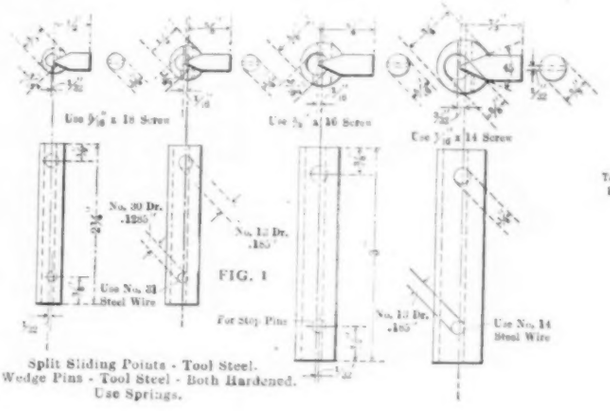

Use ⅜-16 x 18 Screw
Use ⅜ x 16 Screw
Use ⅜-16 x 14 Screw
No. 30 Dr. .1285
No. 12 Dr. .189
No. 12 Dr. .189
Use No. 31 Steel Wire
For Stop Pins
Use No. 14 Steel Wire
Split Sliding Points - Tool Steel.
Wedge Pins - Tool Steel - Both Hardened.
Use Springs.

FIG. 1

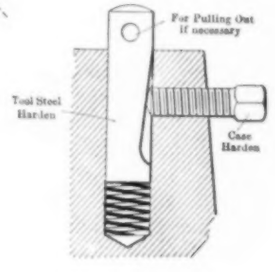


FIG. 2

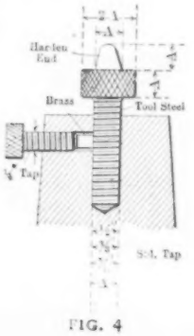


FIG. 4

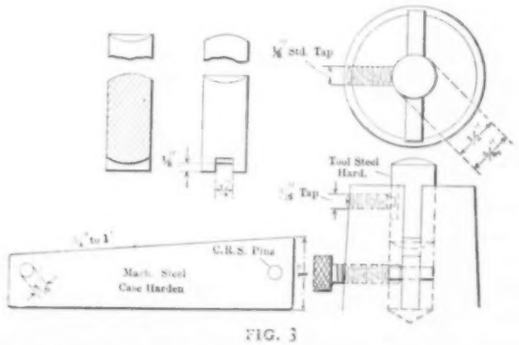


FIG. 3

ADJUSTABLE LOCATING POINTS FOR JIGS

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Saving Material in Turret Lathe Work

I notice an article on the above subject at page 901, Vol. 31, Part 2, which was written by Ralph W. Davis, of Rochester, N. Y.

As he touches on the important question of annular bearings and how they are manufactured, I thought perhaps, owing to the trouble he seems to have with tools for the trepanning operation, you would not object to reproduce the cut and description of the trepanning tool used on the Cleveland automatic, and which was published on page 623, Vol. 30, Part 2. This tool works with exceptional success. There is no danger when using this tool of having the troubles Mr. Davis complains about because the cutting tool is supported in such a manner that it stands up rigidly to the work, regardless of what the width or depth is of the bearing you are machining. This is a good tool not only for annular bearings but for any other class of work that requires an operation of this kind performed.

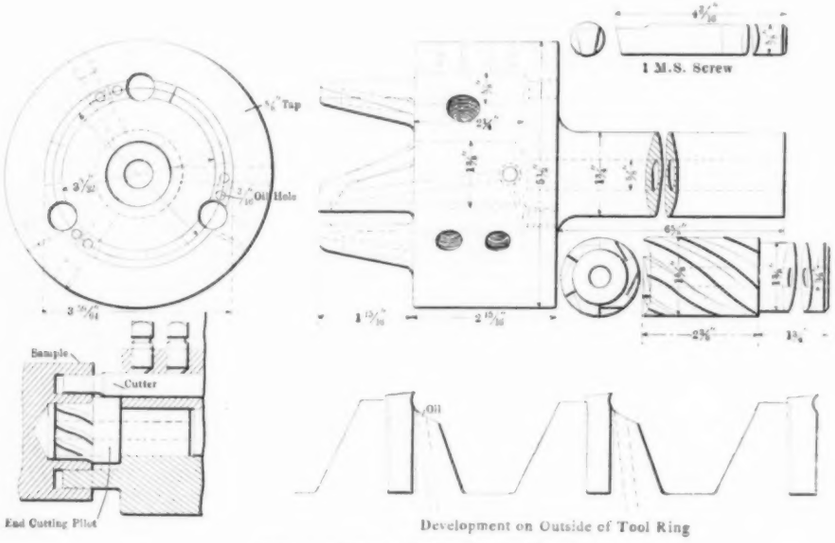


FIG. 1. TREPANNING TOOL HOLDER

A Trepanning Tool

What is known as a trepanning tool is shown in Fig. 1. The work and the tool in place are shown in the lower left-hand corner, while the details of the tool and the holder are given in full. The development of the outside of the tool-supporting ring shows how the tools are supported in place and also the oil holes which allow lubricant to be forced right to the cutting edge. There is also a hole through the shank and through the pilot reamer which keeps this supplied with oil.

The cutters are of round stock with the cutting end squared and ground for clearance, as shown in the detail, which also gives the dimensions. The pilot cuts on the end only, the spiral flutes simply allowing the escape of chips and oil, and guides the whole tool.

To go still farther in the matter, Fig. 2 shows a recessing tool for annular bearings. *W* is a side view, showing the slides carrying the tools. *X* is a top view and *Y* is an end view.

This tool is carried in the turret and, after the trepanning operation is performed, is advanced to its proper position and held there while the cross slide comes in contact with the end of screw *E*. As the cross slide moves forward, the tools *A A* produce the ball groove. The tool on one side producing the groove on the outer ring and the tool on the inside producing the groove on the inner ring. At this time the pin *C* compresses the spring shown in *X* and when the cross slide recedes, the spring carries slides *B B* back to their original positions. The turret then is backed away, leaving the rings machined, ready to be separated from the bar. The tools *A A* have stems that are round (see *Z*) and are clamped by two screws *D D*. *G* (Fig. 2) shows the amount the tools can be ground before they need replacing. As there is considerable to be ground away, you will easily understand that the life of the tool is quite extensive. These tools are made in a fixture, which gives them the correct

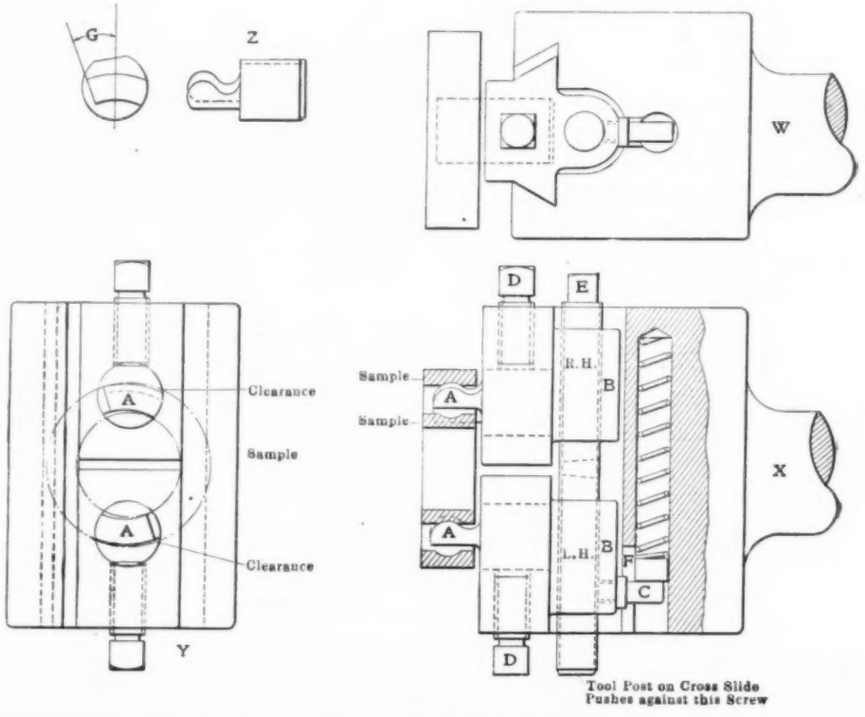


FIG. 2. RECESSING TOOL

shape and clearance, which is shown on Fig. *Y*. When the tools require grinding, the same amount of material is removed from the cutting edge of each one so, when they are clamped by the screws *D D*, the cutting edges will be the same hight. We mean by this, the position of the cutting edges of the two cutting tools will remain the same hight. As they are ground away, considering the clearance, the distance from one cutting edge to the other is lessened and this is taken care of by the screw *E*, which has a right- and left-hand thread. We have used this kind of a tool for quite a length of time and it produces the very best results. It is made of a section quite deep (see *A A*, Fig. *Y*) so if the trepanning tool is narrow, this tool will be sufficiently rigid because of its depth and stands up to its work and does not spring away. You will notice that when this tool is inside the bearing, removing the stock, the overhang is no more than is absolutely necessary to give clearance; that is, the tool slides *B B* are close to the work, allowing no more space than is necessary for the chips to be washed away. Having the necessary amount of lubricant flowing on the cutting tools, with considerable pressure back of it, the chips are carried away very successfully.

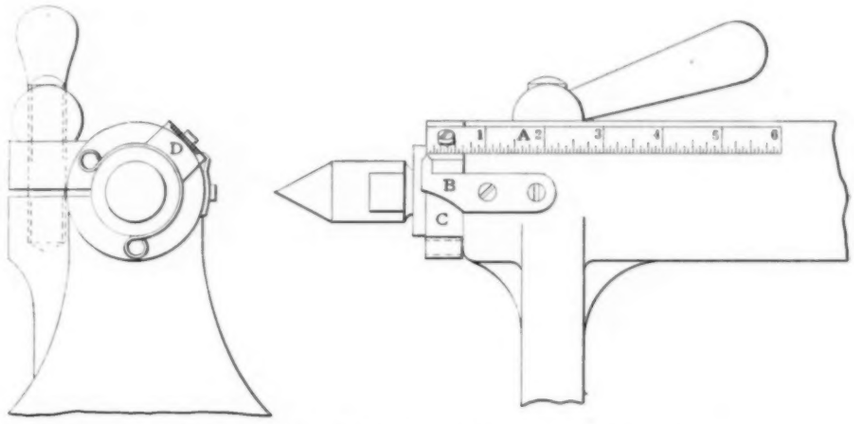
J. P. Brophy.

Cleveland Automatic Machine Company.

A Rack Testing Fixture

At page 895, Vol. 31, part 2, D. F. Trow illustrates and describes a device for testing gear teeth. Along this same line and while that article is still fresh in the minds of readers, I wish to show a fixture for testing cut rack. The fixture, as herewith illustrated, is for testing short lengths of 8-pitch rack and smaller. It is exceedingly sensitive, the ratio of error multiplication being nearly 100 to 1.

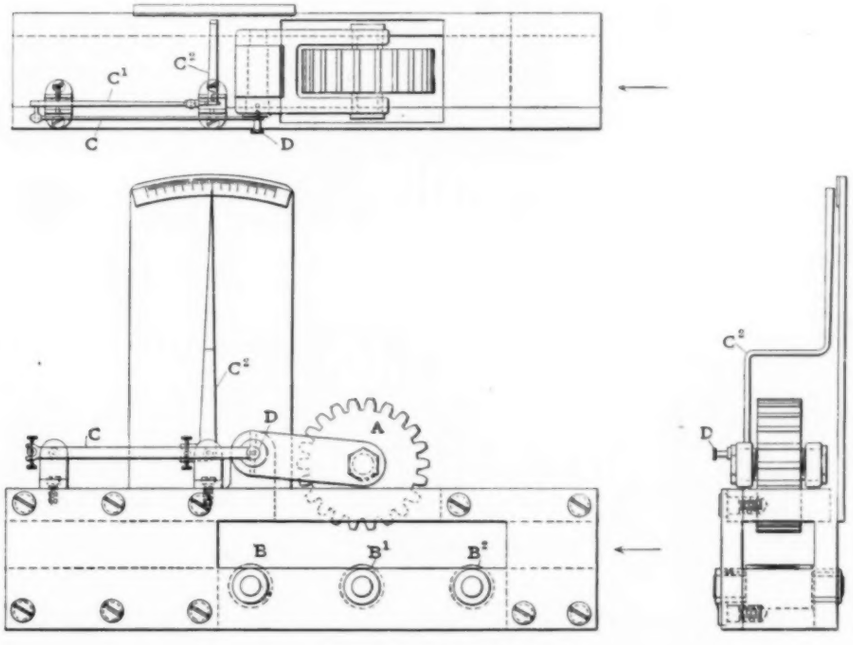
Referring to the illustration, *A* is the master pinion, made of tool steel and hardened. It is a duplicate, so far as size and pitch are concerned, of the pinion which is ultimately run in the rack. *B*, B^1 and B^2 are hardened rollers. *C*, C^1 and C^2 are the multiplying levers.



TAILSTOCK INDICATOR FOR DRILLING IN THE LATHE

Into the opening in the side of the fixture shown in the side elevation, and on the rollers is put a gage, which sets the master pinion to the proper depth. The indicator, or pointer is set central and the binder screw *D* is tightened. The gage is now removed and the rack to be tested is run through the fixture in the direction of the arrow. Through the opening in the side of the machine the rack is marked where irregularities occur.

Cincinnati, O. J. F. Mirrielees.



RACK TESTING FIXTURE

Putting a Scale on Tailstock of Lathe

On page 609 appears an article on "Lathe Details," in which mention is made of graduated tailstock spindles. Most toolmakers are agreed that not much advantage is gained by graduating the spindle itself. This is due to the fact that the divisions on the spindle are not placed in the best position, necessitating either changing the position of tailstock backward or forward to get a reading from graduation, or else a little addition or subtraction of one measurement from another.

The drawings herewith show an attachment which is easily applied to any tailstock, and which gives a direct reading from the end of the scale without regard to the position of the tailstock on the shears It can be used when drilling by means of a drill chuck in the tailstock, or when the tailstock is used to advance a drill which is held in the tool post of the rest.

The attachment is made up of three principal parts, *A* the scale, *B* the indicator, and *C* the spring clip. The spring clip is made of spring steel, hardened and tempered; it is made, as shown, to clip the spindle tightly and yet be able to be moved by hand along the spindle. To it is soft-soldered a brass piece *D*, which fits the spring clip on its lower side, and on its upper side is machined, as shown, to fit the scale *A*, which is held in position by a small screw, as shown. The indicator *B* is of sheet brass, made to shape shown, and fixed by two screws to the tailstock. The use of the attachment may now be described. The die or other article to be drilled is in the chuck; the drill is advanced by the tailstock in the usual manner until its point touches the work; now the clip and scale are pushed back until the clip touches the tailstock, when the scale reads at zero, as shown. Any advance of the drill may now be read off on the scale as the actual depth of the

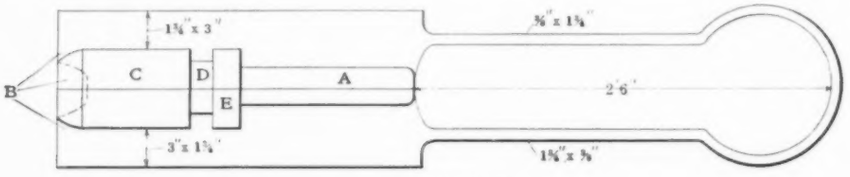
hole. The scale, shown, reads to 6 inches, but any other length may be used as thought fit.

WILFRID GEORGE.

Birmingham, England.

Hardening Pneumatic Hammer Snaps

In answer to the inquiry on page 753, regarding the continued breaking of snaps used in the pneumatic hammer working at an air pressure of 80 pounds per square inch, the following is what I am using at the present time after having experienced the same difficulty. I am at present using a pneumatic hammer with air pressure at 100 pounds per square inch.



THE FORGING TOOL

I use 1¾-inch octagon Jessop's cast steel, specially made for riveter's snaps, at an approximate cost of 6 pence per pound. A smith forges them in a pair of spring-forging tools, shown in the illustration. The snap is turned at *A*, the smith only leaving 1/16 inch to turn off in a turret lathe. *B* is turned to suit the size of rivet head required. *C* is left black, as are also *D* and *E*.

My method of hardening is simple, but effective. I heat the snap at the end *B* only to a cherry red and quench in oil, *A*, downward; let the snap remain in the oil for two minutes only, then put on the floor to cool down of its own accord. The end *A* you would imagine would be too soft, but I find this is not so if you round the end of *A* pretty well off, as shown. I have found, after putting some hundreds of ⅞-inch rivets in, that the end *A* has swollen a little; I take it out and ease it; in no case has it swollen a second time. Since I have adopted this plan we seldom see a broken snap about the place.

Stockport, England. W. HOLT

Two Heat Shrinks

In reply to T. Toot's query on page 753, Vol. 31, Part 2, of the AMERICAN MACHINIST I will say that there is no doubt that when the steel collar was heated it would expand to a considerable size above the shaft it had to fit on, and being slipped on to a cold shaft the inside of the collar would receive a chill and, therefore, prevent the outside metal from contracting sufficiently to close the hole tight on the shaft, but it would warm the shaft. Therefore, the second time the collar was put on, it would not receive such a sudden chill as at first with the results that when the outside was cooled off it would compress or close in the inner metal and make a tight fit. The best remedy is to give the collar a good heat and at the same time slightly warm the shaft, then cool it off by pouring water on the outside of the collar as quickly as possible.

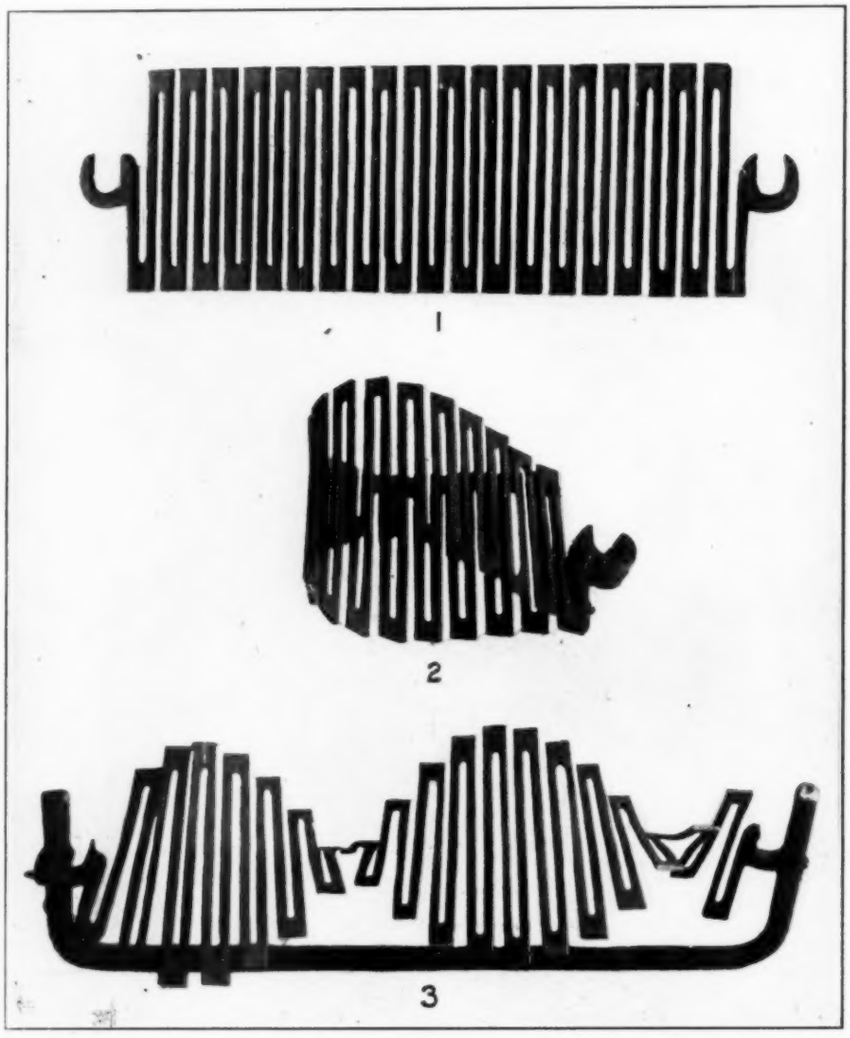
Darlaston, Eng. H. MAPLETHORPE.

Elasticity of Cast Iron

Referring to the article, "Interesting Examples of the Elasticity of Cast Iron," which appeared at page 744, Vol. 31, Part 2, I send you some further examples, which perhaps will be of even greater interest to readers.

These show the high elasticity of cast iron under certain conditions, illustrations 1 to 3 showing a resistance grid as manufactured by the foundry department of Ludwig Loewe & Company, Berlin, Germany in a variety of shapes and sizes. The length of the grid, as illustrated, is 9½ inches. The iron used in these particular grids is a special mixture, cast under known conditions. Fig. 1 shows the grid in its normal state, while in Fig. 2 it is bent, so that the ends meet, and in Fig. 3 it is twisted completely round. The grids resist these abnormal strains dozens of times without breaking.

It is necessary to emphasize the fact that the material is simply cast iron which has undergone no further treatment whatever after casting. These remarkable results, however, are only achieved by regularly and systematically testing the pig iron in the first instance and the various mixtures afterward, as is done at Ludwig Loewe's works, where the foundry



STARTLING EXAMPLES OF ELASTICITY OF CAST IRON

is worl ng under continuous control by the che ical laboratory.

W. POCKRANDT.

Charlottenburg, Germany.

Grinder for Switch Point Pins

The grinding machine illustrated and described on page 921, Vol. 31, which was designed and built by Mr. Nichols for the purpose of grinding manganese-steel switch-point pins, recalls a device I saw in use at the Fulton Iron Works, about three years ago.

The work to be done consisted of the truing and sizing of pins 6 inches long and 8 inches in diameter, placed near each end of a bar 8 feet long, 10 inches wide and 4 inches thick. There were ten of these bars making twenty pins to be machined.

The bars were intended for a specially designed ore-working machine and were made, pins and all, of one solid piece of very hard and tough steel.

The size of the pins allowed of a variation of about 1/32 of an inch from the nominal 8 inches, when finished, but it was considered important that the pins be of the same diameter for their full length and that they be perfectly at right angles with the bar, the back of which was ground. Originally it was intended to plane the back of the bar and finish the pins with a box tool in a drill press, but an attempt to plane the bars changed this idea. Luckily the shop possessed a surface grinder large enough for the work, but nothing to grind the pins was at hand and as there was little likelihood of ever having another similar job, it was not thought advisable to go to very much expense, so the device shown in cut was rigged up. The machine on which the work was done was a heavy radial drill press, having a 4-inch spindle, and the grinder was a heavy electric center grinder *T*, of the usual type.

The tool-post bar and feeding mechanism of the grinder were removed and a forged-up piece *A* fitted on. This piece was split at the large end and clamped to the ways of the grinder by means of the two cap screws as shown.

The square shank of the forging was carefully shaped up and threads cut on it for about one-third of the length. A box arrangement with a Morse taper shank attached was then made for the part *A* to slide in, the lower cap *B* being scraped to a good tight fit. Feeding out or in was done with the nurled nut *C*, the clips *D* holding the nut close to the outer sleeve at all times.

The spindle sleeve is shown at *W* and the line spindle at *X*. The regular drift hole is at *G* while *F* shows the taper wedge used to hold the Morse shank firmly in place in the live spindle.

The electric contact rings *J* and *H* were made of brass strips bent into a ring and soldered so as to measure about 4⅛ inches inside. The ends were carefully beveled off smooth and paper was wrapped around the spindle sleeve and the rings pressed on and wires soldered to them, the wire from *H* passing under ring *J* from which it was well insulated. Both wires *O* were fastened to a plug fitting the regular light sockets. The wires from the grinder were soldered to copper bushes fastened to and insulated from the arm *K*.

As the electric grinder spindle ran the wrong way to do the best grinding with the drill spindle running right, the motor was reversed by changing the armature wires around. The first thought was to run the drill-press spindle backward by crossing the belt but some difficulties of the feed and automatic stop prevented this.

With the motor reversed, of course, the spindle and nut had a tendency to unscrew, so the extension spindle was pinned as at *M* and a lock nut put on at *N*.

Considerable metal had to be ground off of pin *P*, but good time was made. The bar was securely clamped to the platen and the automatic spindle feed was used with a stop set for the right depth.

Decatur, Ill. ETHAN VIALL.

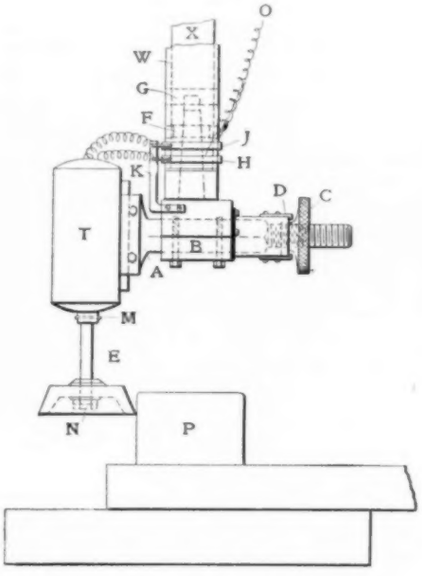
Leveling Horses for Balancing Pulleys

In response to the request of F. A. J., on page 934, Vol. 31, Part 2, for leveling horses for balancing pulleys, I inclose a sketch of one which is used satisfactorily on pulleys up to 16 feet diameter and weighing as much as five tons.

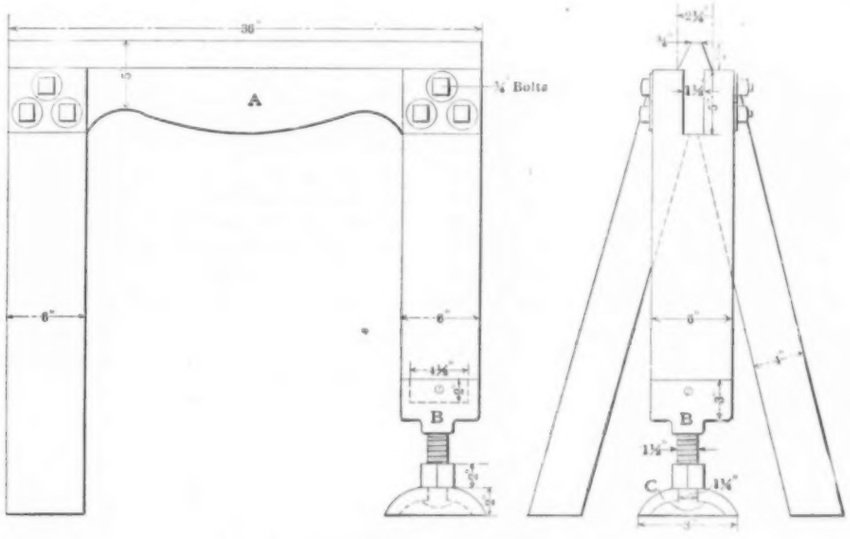
Parts *A B C* are cast iron. The legs are maple. The screw is steel and has the foot *C* riveted on loosely. The single leg is bored out to clear the screw which should have an adjustment of about 2 inches either way.

This horse is portable and easily handled by one man and so can be set wherever the pulleys happen to be. By placing the pair of horses opposite ways they can be brought close together. They should be leveled up with the pulley in place as the weight of the work may spring the floor. The legs can be made any hight. Those shown are about 4 feet, and can be used over a pit for work larger than 8 feet in diameter.

Ottawa, Can. J. STEVENSON.



USING A TOOL-POST GRINDER IN A RADIAL DRILL



LEVELING HORSES FOR BALANCING PULLEYS

A Patent Experience

I have been much interested in the articles by Wit Bec, descriptive of the trials and tribulations (successes, too,) of his inventor friends. I have been interested, not alone because I have for some years made a special study of the more technical phase of the patent subject, but because the stories recalled to my mind many similar experiences which have come under my own observation. They have recalled particularly one experience, in which I was myself an "accessory after the fact" a number of years ago, and which happened about as follows:

A friend of mine whom I shall call "Watson," was, at the time of which I write, employed in a certain printing and binding establishment that made, among other things, a line of salesman's pads, similar to those in use in our large stores today. The establishment was a small one in a small town; the pads were printed and bound in such a manner that the machines would turn out only a few hundred per day. Now Watson was a fellow who thought while he worked; he conceived the idea of an attachment for the presses whereby the pads or similar work could be manufactured some eight or ten times as rapidly as by the old method, and would dispense with the services of several skilled operatives. In fact, the device would make the manufacture of this class of product almost an automatic process.

A patent was applied for by Watson, and in due course he was invested by our Government with the "exclusive right to make, use and vend the said invention" for a term of 17 years. As there was no contract between Watson and his employer in relation to patents, the firm was entitled to nothing except the shop right to the invention; so Watson gave them a limited license to use the experimental machines which had already been made. This satisfied the concern and, of course, left Watson free to dispose of his invention as he saw fit. Being rather "short" of funds, he came to me to aid in financing the project. I bought an interest in his invention for which I paid to him $300 in cash. This fund, together with our patent, represented our only available assets. We therefore determined to use the money in negotiating the sale of the patent.

The A——— B——— Company, one of the large manufacturers of special machines like ours, saw our device in operation and immediately evidenced much interest in it. We made a number of visits to their factory, each trip costing us in the neighborhood of $50, but we had high hopes of selling out for $5000, which was the conservative figure we placed on our patent. We exhibited the working models, and even allowed the A——— B——— Company to take our drawings for examination. Imagine our chagrin when we were informed one day, just when our hopes had reached their highest notch, that the A——— B——— Company had been experimenting with a machine which they said was far superior to ours, and they were about ready to place it on the market. In a few weeks their advertisements appeared, and they sold several machines equipped with an attachment which we examined and found was a direct copy of ours and a rank infringement of our patent.

We had but $65 left of our "sinking" fund, and this we turned over bodily to a learned lawyer to tell us that while the A——— B——— Company was without doubt infringing our patent, and that the only course we could pursue was to sue them in a Federal court, it would probably cost us as much as $5000 to properly defend our patent rights. He gave us the further comforting assurance that this estimate of cost was based on the assumption that the A——— B——— Company lost the case in the trial court and did not appeal it to the higher courts, in which latter event the costs would be higher.

Here we had an official document from the United States Government granting us the *"exclusive right* to make, use and vend" our invention, and yet we were utterly powerless to do any of these things.

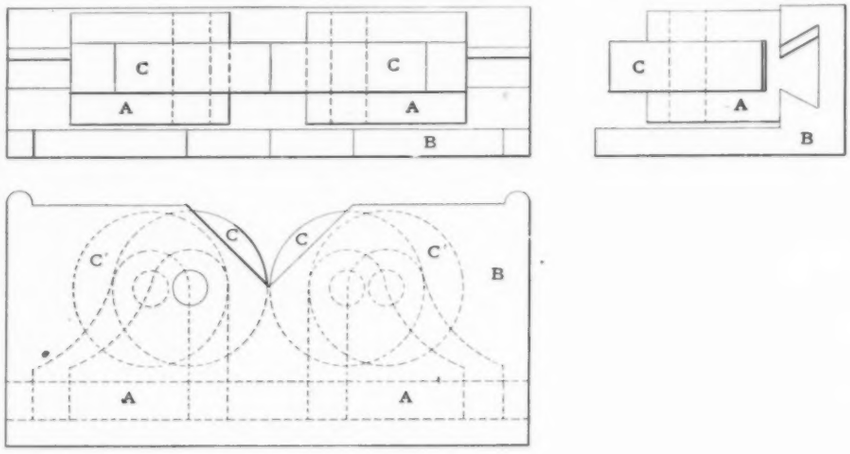
Someone of pessimistic turn has said that a patent is worth the amount of money back of it for defense; someone else has defined a patent as "an invitation to a first-class law suit." It may well be believed that in our despair we were willing to believe all this and worse. Watson threw up his hands and I was about ready to do so, when happily for us I heard a rumor that the C——— D——— Manufacturing Company was rapidly encroaching on the A——— B——— Company's trade, and they were bitter rivals. This gave us our cue. To make a long story brief, we sold out to the C——— D——— Manufacturing Company for $5000; they brought suit against the A——— B——— Company on our patent; won; enjoined them from infringing and, so far as I know, are today "making, using and vending" our invention in a very satisfactory and profitable manner. The moral is that a patent is not always a luxury which no poor man can afford.

Alliance, Ohio. PATENTEE

Balancing Ways

There have from time to time appeared in the AMERICAN MACHINIST various designs of balancing ways. All, or nearly all have been provided with rollers for the shaft to rest on but I do not recollect seeing any in which the rollers were protected from accidental damage when lowering the shaft and work into place. The cut herewith shows a balancing device which I made after a faulty chain hoist had bent the roller spindles by allowing the load to fall about a foot.

The base *B* is planed on the bottom and in the V for the two brackets *A* which carry the balancing rollers *C*. The top of the upright of the base *B* is a little higher than the tops of the balancing rollers. The brackets *A* are connected with a right- and left-hand screw having both ends squared for a handle or wrench and the bearing for the screw is in the center just under the V; the screw and its bearing are not shown. When lowering the work to be balanced onto the ways, the brackets are run out so that the rollers are in the position *C'* in the elevation. The job is then lowered into the V in the vertical member of the base *B*. When the work is resting in the V's (there being, of course, a balancing way at each end of the shaft) the wrench is applied to the end of each right- and left-hand screw and the brackets carrying the rollers are brought together lifting the work. If the work be very heavy the chain blocks assist. Two little humps at either end of the vertical member prevent shafts rolling off should they be laid on top. The cut is not to scale and is merely to give a general idea of how the device was made.



BALANCING WAYS

New York. E. A. DIXIE.

How Should a Boy Go About Becoming a Mechanical Engineer?

The questions which James Watt asks at page 710, Vol. 31, Part 2, could still more pertinently be asked within the school doors. Which is best, that construction work should precede or follow the theoretical consideration of the principles involved? Most college catalogs dodge this question by saying that their shops go hand in hand with the theoretical class-room work, so that the same problems are worked out at practically the same time. As a matter of fact, it is an accident if this is the case, neither shop instructor nor class-room instructor paying much regard to what the other is doing.

The natural process of acquiring experience and then that knowledge, involves the doing of something and the sitting down to think it over. At the risk of criticism I must say that science waits after practice and finds an excuse for things working. It does, after a time, enable men to predict that certain things will happen under certain conditions, but it is hard to find many instances in which a man, by merely sitting down and thinking, has declared a fact new to the practical world.

This being the case, it is natural for us to try things and then theorize about them. Instead of that we, in the schools, have made practice subservient to theory, and in consequence have sent out our graduates with a notion of the progress of science, which is contrary to the truth. Our young graduate has worked over the beam theory, for example, and then has tested beams to prove its truth, therefore he instinctively feels that the theory came first and, therefore, the theory to him is the most important, little realizing how many years beams were designed to safely carry loads before the present theory was evolved, and never dreaming that many other theories have been proposed and for the time being accepted.

What I propose is this, that following the natural course of life we should first teach our boys to do things, in the shop, in the laboratory, over the drawing board, teaching them to observe by asking and insisting on answers to pertinent questions. Then, after they have acquired the habit of doing they should be taught to think about these things in the class room, their problems being taken from their previous shop and laboratory experience. Then I would send them back to the shop to plan and arrange and direct and inspect the work of lower classmen who are going through the same process that they did.

Boston, Mass. "INSTRUCTOR."

The Suggestion System

The most successful suggestion system that I have ever seen was one that was used by my friend, W———, when he was superintendent for the M. M. Company. He did his own designing, but whenever he was at work on anything new he would go out in the shop every little while and ask one of the "boys" if he thought a shaft, or a screw, or a gear, or what not on the old machine was heavy enough. Before he got through talking, like as not he had them in the little closet he called the drafting room. He put all these fellows entirely at ease with him too. It is very different in its psychological effect to send out a messenger boy and call a workman into the office, from what it is to go out and sit on a bench with him and talk about some matter. Most workmen are more or less afraid of the office. They feel like a fish out of water, and they flop around, mentally, about the same way. These men in the shop want recognition just as much as actors on the stage. As a rule they do not get it. Politicians are about the only people who realize this value in recognition. Consequently a politician who will let politics alone and run a shop can get his suggestions from his men at no cost, save the decently friendly word that so few of us realize is necessary except to our "betters;" as if it were not likely that every man we meet may be our "better" in one way or another.

Springfield, Mass. ENTROPY.

Alinement of Turret Lathes

Under the above heading on page 936 Vol. 31, Part 2, Mr. Abbott tells of a method some turret-lathe builders use in boring the holes in the turrets. While the method he explains is accurate enough I fail to see the necessity of drilling the holes with a jig.

The following method is one I used in a plant where they built a great many turret-lathes. The machines were put through in lots of 30 or more. They were assembled and finished complete with the turret left blank. Then a solid collet which had a taper hole to fit the shanks of the drills to be used was put in in place of the split collet. Then the drill was inserted in the collet and the carriage carrying the turret fed to the drill by means of a hand wheel and screw. When one hole was drilled the turret was indexed and another hole drilled, etc., until all the holes were drilled, then the drill was replaced by a boring tool and the holes bored to size. While this method is no more accurate than the method Mr. Abbott explains, it has this advantage. The saving of the cost of the jig or jigs, as several would be necessary on account of the different size turrets on different sized machines and the various number of holes used in the turrets. The same size machine having turrets with four, five, six and eight holes. Also the advantage of not tying up a drill press for several days every time a lot of machines were put through.

Lowell, Mass. R. H. VICTORY.

The New British Patent Act and a Recent Decision

As considerable importers of American goods into Great Britain, we are interested largely in American trade and in the interests of American manufacturers whom we represent, as well as others. The serious situation for American owners of British patents created by the new patent law in this country, requires prompt and serious consideration.

As you are probably aware, under the new act a British patent which is not worked to an adequate extent in this country, but which is worked abroad, is subject to revocation at the instance of any applicant.

We believe that, up to the present, legal advisors in America have held that, seeing that in most cases the parts of a patented construction are not covered by the patent, but only the mechanical combination as a whole, it will be sufficient to manufacture the parts in America and have them assembled here, and in the interests of some of the American firms whose goods we are handling here, we have carried out this assembly work for them.

By a decision just given, however—the second decision under the new act—this contention appears to have been knocked on the head, as patent No. 26,519 of 1906—an American patent on a lockstitch sewing machine—has been revoked. In this machine most of the parts entering into its composition were manufactured in the United States and imported here, and, together with some parts manufactured here, assembled for sale. The comptroller-general ruled that "the American patentees had not 'adequately worked' their patent in England by merely making a small number of substituted parts." It seems to us, therefore, that assembly here will not suffice to protect the rights of American patent owners and that nothing short of complete manufacture on this side will suffice, and this point should at once be recognized by interested firms in the United States.

THE BRITISH-AMERICAN COMPANY.
Coventry, England.

Reports received by the Geological Survey during the six years from 1902 to 1907 show that the production of cement in the United States has increased from 25,000,000 barrels, valued at approximately $25,000,000, to 51,000,000 barrels, valued at $55,000,000.

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The Canadian Timber Supply

There is a very prevalent and complacent feeling in this country that when our forests are exhausted we have only to remove our tariff on timber and draw upon the supposed immense resources of Canada. The average American considers Canada, except for its lower border, to be one vast expanse of virgin forest, an opinion which has nothing behind it but a knowledge of the original condition of much of our own territory in which clearing away the forests was the first and necessary act of the original settlers.

This subject was discussed in an article on "The Industrial Development of Canada," printed on page 564 of Vol. 29, Part 2, after a trip through that country by one of our editors, during which careful inquiries were made regarding the extent to which the Canadians are importing timber from the United States and their limited domestic supply, together with others at more primary sources of information. The result of these inquiries was to show that the Canadian timber supply, instead of being large, is, in reality, small, and that any expectations that may be held in this country to the contrary are doomed to disappointment. It is a fact, as there pointed out, that of hardwood Canada imports nearly all of her supply from this country. This alone is not perhaps surprising, as hardwoods do not grow in northern latitudes, but coupled with it is the fact, which is surprising, that large amounts of white and yellow pine go from this country for Canadian consumption.

The article to which we refer is strikingly confirmed by another entitled, "An Analysis of Canada's Timber Wealth," which appears in a recent number of the *Canadian Engineer*. Of course, Canada is a new country of which much remains to be learned regarding its natural resources, and the author of this article recognizes that his conclusions are of a very general character. They are, however, distinctly and unhesitatingly pessimistic, as a few extracts will show. Thus, regarding original conditions we find the following:

"Comparing Canada with the United States in their forest conditions two facts at once impress themselves, namely, the greater variety of forest types and the greater extent of continuous valuable timber areas in the latter. No such thing as the extensive southern pineries, in which almost every acre contains merchantable material, is to be found in Canada, and no such variety of species of value is to be found as the forests of the United States offer.

"Everything is simpler in Canada as its geology and topography and its entirely northern climate would lead one to expect, and her limited areas of merchantable saw material are distributed through a large area of inferior growth; the commercial timber occurs mainly in patches. And we may say at once, that while, perhaps, a larger area than of the States exhibits woodland conditions, the commercial timber area, actual and potential, is decidedly smaller."

Scattered through the article we find further comments of the same character. Thus referring to the peninsula of Ontario between the Great Lakes we find this: "Here we find an extension of the southern hardwood flora, ... all in magnificent development where any of them are left. Here is the garden spot of Canada, here on an area of 18,000 square miles lives half the population of Canada and practically all of the commercial timber is cut away to give room for farms."

Referring to the country north of the St. Lawrence valley we are told that, "A century of logging has removed the accessible pines very nearly, and while it is impossible to make even a guess at the amount still standing, the fact that hemlock is cut in ever increasing amounts sheds light on the situation. . . . . Those who realize that the commercially available and accessible saw timber is near exhaustion point to the enormous amount of pulp-wood material as the value for the future."

Referring to the country farther north we are told that, "Looking at the economic value of these northern woodlands, everybody must see that their timber, although of inferior character, is of utmost value for home use by the prospective settler and miner and of no commercial value to our eastern civilization." Referring to British Columbia, the paper reads: "The Government has disposed of at least two-thirds of the coast timber and of one-half the mountain timber, and only 6,000,000 acres believed to be of good timber are not disposed of." And of the northern forests of this province we are told that, "So far as known not much of commercial value, especially for sawmill use, except for local consumption, may be expected." And referring to the southern Lawrencian forests we are told that "The good saw timber is so irregular in its distribution that one can travel hundreds of miles without seeing any of it." Of the Maritime provinces we are told, "This area is practically cut out as far as pine is concerned, and relies now mainly on spruce for saw timber."

The report concludes with the following paragraph:

"Considering that the above estimated stand of saw timber, which others have considerably reduced, would not suffice to supply the present annual consumption of coniferous material in the United States for more than 15 to 20 years, and the import into Great Britain of this class of material for more than 60 to 80 years, the need of securing better knowledge of the conditions of this resource and of employing conservative methods in its use are apparent."

These few quotations are enough to make it plain that expectations based on a supply of timber from our northern neighbor after our own is exhausted are doomed to nothing but disappointment. It seems to be a universal law that valuable timber is of southern and not of northern growth, the most valuable timbers, such as mahogany and rosewood, growing in tropical climates, from which, as we go north, timber becomes increasingly of the softer varieties, the hardwoods being replaced in succession by yellow pine and white pine, which in turn give way to the comparatively worthless spruce and fir.

A Foremen Machinists' Club

The foremen machinists of Bridgeport, Conn., have formed a club, which they have named The Society of Mechanical Foremen, for the purpose of social and intellectual intercourse. All foremen of a good moral character and engaged in the manufacture of metal goods are eligible to membership after being properly vouched for.

The social end is provided for by a large and neatly furnished room which is open to members and friends at all times. Many games are provided, but gambling and intoxicating drinks are barred.

The club has started a mechanical library of 36 volumes, which were presented by the Bullard Machine Tool Company, while a large number of magazines are at present supplied by the members. A blackboard adorns the walls to be used to illustrate lectures of which they hope to have many.

Manufacturing companies will soon be requested to put the society on their mailing lists so far as their advertising matter is concerned, and to have their salesmen spend their evenings in the club room when stopping in Bridgeport. The membership now numbers 45.

The Hudson-Fulton Celebration

The program of the celebration of the centenary of the opening of steam navigation by Robert Fulton on the Hudson river, and of the third centenary of the discovery of the river by Henry Hudson has been announced. The entire Hudson valley will take part in the celebration, which begins September 25, and will continue until October 9. Among the ceremonies is to be a naval parade up the river in which one of the participants will be a fac-simile of Fulton's first steamboat, the "Clermont," and one a fac-simile of Hudson's "Half-Moon," the first ship to enter the river. This fac-simile of the "Half-Moon" is now being built by the people of Holland. The celebration is expected to surpass anything of the kind ever seen in this country, and in view of the events which it is to celebrate it is to be hoped that the expectations will be more than realized.

Personals*

Burt C. Wear is at present engaged with the Republic Iron and Steel Company, Youngstown, Ohio, in their engineering department.

Oliver B. Zimmerman, who has been with the Hart Parr Company as chief draftsman, has assumed a similar position with the M. Rumely Company, La Porte, Ind.

Karl Hawkins, lately superintendent for Nelson Brothers Company, Chicago, is now managing partner in the new firm of Hawkins Co., 6523 Wentworth avenue, Chicago.

Edward C. Wells, for some time manager of the Quincy Engineering Works, has recently become superintendent of the Hardie-Tynes Manufacturing Company, Birmingham, Ala.

Thomas J. Walsh, until recently connected with Woonsocket Electric Machine and Power Company, has joined the mechanical forces of the Tampa Electrical Company, Tampa, Fla.

Edward R. Feicht, formerly associated with the Westinghouse Machine Company as erecting engineer, has accepted a position with the American Beet Sugar Company as master mechanic.

A. L. Lovejoy, formerly connected with the Becker-Brainard Milling Machine Company, has recently associated himself with the Pratt & Whitney Company as manager of their sales department.

John P. Cosgro has been appointed district manager of the Allis-Chalmers Company with offices at El Paso, Texas. Mr. Cosgro has had an extensive experience which includes service with the Union Iron Works.

Herman G. Jakobsson is now associated with the engineering department of the Midvale Steel Company, Philadelphia, Penn. Mr. Jakobsson was formerly chief ordnance draftsman of the Bethlehem Steel Company.

Henry Souther, of Hartford, Conn., has entered into an arrangement with the Standard Roller Bearing Company, of Philadelphia, whereby he will devote considerable of his time to its interests as consulting engineer.

Charles A. Berger, formerly foreman at the works of the Warner & Swasey Company, and later assistant superintendent of the John B. Morris Foundry Company, of Cincinnati, is now connected with the Elmer H. Catlin Company, of Washington, D. C., as superintendent.

E. W. Goldschmidt, New York manager of the Wagner Electric Manufacturing Company, and formerly of Chicago, sailed from Antwerp January 16 on his return to this country after a four months' vacation. Mr. Goldschmidt has been touring the continent by automobile, after spending a couple of months rusticating in southern Italy. Fortunately he left there before the recent earthquake.

*Items for this column are solicited.

Museum of Safety and Sanitation

Announcement has just been made of the acceptance of the treasurership of the Museum of Safety and Sanitation by Frank A. Vanderlip. An executive office for the administrative and promotive work of the museum has been opened at the United Engineering Societies' building, 29 West Thirty-ninth street.

A committee on plan and scope includes Prof. F. R. Hutton, chairman; Dr. Thomas Darlington, commissioner of the Health Department of the City of New York; P. T. Dodge, president of the Engineers' Club; William J. Moran, attorney-at-law and Henry D. Whitfield, architect.

Plans are being pushed forward along practicable lines to prevent the enormous loss of American life and limb, through the Museum of Safety and Sanitation, where safety devices for dangerous machines and preventable methods of combating dread diseases may be demonstrated. Charles Kirchhoff, editor of *The Iron Age*, is the chairman of the committee of direction; T. C. Martin, editor of *The Electrical World*, vice-chairman, and Dr. William H. Tolman, director.

Meeting of the American Foundrymen's Association

The meeting of the American Foundrymen's Association and its allied bodies is announced for the week of May 17, at Cincinnati.

New Publications

A Brief Course in Machine Drawing. By Frank E. Mathewson. 23 8x6 pages, paper covers. The Taylor Holden Company, Springfield, Mass. Price, 40 cents, postpaid.

This little book is intended as a brief course in machine drawing for classes where only a limited amount of time is available for the subject. Or it may be used as a supplementary course in connection with the Notes for Mechanical Drawing, by the same author. Many of the plates are arranged to establish in the mind of the student a definite connection between a perspective sketch and a working drawing of the same object or parts. This connection, of course, must be thoroughly understood before intelligent working drawings can be made. Other plates are dimensioned assembly drawings from which the student is expected to prepare sheets of details. While from the nature of the book it covers but a limited amount of ground, it covers that ground thoroughly, and should prove of a real help to teachers and students of mechanical

drawing where only a short period of time can be devoted to the work.

FOUR PLACE TABLES. Unabridged Edition. By E. V. Huntington. 32 7x10-inch pages. The Harvard Co-Operative Society, Cambridge, Mass. Price, in flexible cloth, 60 cents.

These tables comprise four-place tables of logarithms and trigonometric functions and auxiliary tables (chiefly to three figures) of squares, square roots, cubes, cube roots, reciprocals, circumferences and areas of circles, exponentials, natural logarithms, radians, and convenient constants. Two features deserve notice. The one, the unit in which the tables of angles are expressed; the other, the marginal index. All angles and parts thereof are expressed in degrees and decimal parts of a degree, instead of in degrees, minutes and seconds. A conversion table is provided by means of which decimal parts of a degree can be converted into minutes and seconds if desired. The marginal index is provided with tabs at the side and also at the top and bottom edges. By their use any matter in the tables can be turned to at once, with either the right hand or left hand, as the user wishes. The type is large and clear, the paper has a dull finish, thus making tables that are easily read.

LIQUID AND GASEOUS FUELS. By Vivian C. Lewes. 322 5½x8¼-inch pages; 54 illustrations; indexed. D. Van Nostrand Company, New York City. Price, $2 net.

This work is a successful attempt to treat the subject of liquid and gaseous fuels from a popular, but comprehensive point of view. It is not in the nature of a work of reference, but rather gives a general sketch of the subject of fuels, other than solid fuels, and their bearings on the power problem of the day. The first three chapters deal with the phenomena of combustion and the part played by the atmosphere, the formation of fuel in its various forms and the methods by which the values of fuels are determined. The following chapters give an account of the production and use of liquid fuels, and their adoption as an auxiliary to coal in European navies. The subject of coal gas, and the factors which have made it one of the most important of domestic fuels, are also treated at considerable length. Water gas, both as a help to the coal-gas maker and the engineer receives due attention. The gases which, although poor in thermal value, have proved themselves the most valuable in cheapening power production are fully treated in the section dealing with poor gases and the suction plant. The last chapter deals with the future of the fuel problem, and the probable lines on which the world of the future will find the energy which it will need for continued life and prosperity. From this last chapter we quote: "It is to the growing plant that we must turn for the main supply of energy generated in the fuelless world of the future." And again: "When the great demand for alcohol as a fuel arises, it will be found that vegetation in all its forms will, by proper treatment, yield to fermentation and give us a means of regenerating the energy that caused its growth." An appendix contains a number of useful tables, and there are four pages of bibliography.

PATENTS. By Edwin J. Prindle. 134 5x7¼-inch pages; indexed. The Engineering Magazine, New York City. Price, $2.

A most striking, interesting and valuable treatment of the subject of patents is presented in this volume. Its purpose is to present information that will be of direct value to the manufacturer who owns or controls patents, and to patentees and would-be patentees, but it does not aim to make either the manufacturer or the patentee his own lawyer. Fundamental principles are laid down in a clear manner so that anyone can follow the right course in the early steps that lead up to the application for a patent, and prior to securing the advice of competent counsel. There are six chapters with the following titles: Influence of Patents in Controlling a Market; Subject, Nature and Claim of a Patent; What Protection a Patent Affords; Of Infringements; Patenting a New Product; Patent Relations of Employer and Employee; Contest Between Rival Claimants to an Invention. Of these, Chapter 3, What Protection a Patent Affords, is of especial value, as it shows that there are three ways in which the advantages of a patent as applied to a given article may be secured; through making or licensing to make, through selling or licensing to sell. Often a patent may have a most valuable application in an industry remote from the industry for which it was originally developed. Chapter 4, Of Infringements, brings out several points which are not generally appreciated. Among these is the right of parties in repairing and reconstructing patented devices. We quote, "a patented device which is worn out cannot be repaired, even if its separate parts are not patented, and cannot be repaired or its parts replaced if in doing this the identity of the machine is destroyed." The work is one of the most valuable additions to the Work's Management Library that it has been our pleasure to review.

SAXTON'S LOGS FOR FOUR-PLACE WORK. E. Saxton. 3¾x11-inch pages, tables and text. E. Saxton, 841 Bladensburg Road, Washington, D. C. Price, in leather, $3.

In spite of the large number of logarithm tables that have appeared of various kinds and with various arrangements, the author has succeeded in producing a work that is radically different from the conventional type and one that is possessed of merit. The novel features are: A double-marginal exposed index from which the logarithms of one-place and two-place numbers are read without opening the book, and by means of which the book is opened directly to any data in the table; a table of great legibility, for the type is large and the logarithm of every number is printed opposite that number; a table from which the logarithm of a reciprocal of a number is read as easily as the logarithm of the number itself; an explanatory text that shows the simplicity of logarithmic computations and wisely lays considerable stress on the use of the reciprocal. The first feature is secured by cutting the edges of the leaves into a two-column, finger index exposing the integral numbers from 10 to 99, inclusive, and opposite them the mantissa of their logarithm. To find the logarithms of a given number, open the book at the index number represented by the first two figures of the number whose logarithm is sought. To find the anti-logarithm of a logarithm, open at the next lower logarithm shown on the index. The element of legibility is secured by very large type and wide spacings. Each page has but three vertical columns, the first of which contains numbers, the second the logarithms of those numbers and the third the logarithms of the reciprocals of those numbers. Duplicating figures in every column are omitted, and their absence may be pointed out as a possible disadvantage in the arrangement. The introduction of the logarithm of the reciprocal, and the explanatory text showing the uses to which the reciprocal can be put in computations are worthy of commendation. Subtraction of logarithms is made unnecessary. These logarithms of reciprocals can save time and trouble, by reducing the solution of mixed products and quotients to simple additions of tabulated quantities. Undoubtedly regular users of logarithms will find here valuable hints in regard to this class of calculations. It will be noted that most of the advantages of this work lie in the mechanical arrangement of the index, for it requires 90 double pages for the numbers from 1 to 9999, whereas the average arrangement requires but nine. As the advantage of the work is in the index, the durability of the index will determine the ultimate value of the work. This feature is recognized by the author, for a sheet of heavy cardboard is provided to be slipped under the front cover as a protection to the index when it is not in use. In the text a considerable point is made of unnecessary refinements in calculations. This position is perfectly sane, as four-place logarithms give results that are amply accurate for many engineering computations. Taken all in all, the author has produced an implement, or tool, of considerable value to the engineer.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Universal Cutter Grinder

This machine has been designed to grind all kinds of cutters and tools used in the machine shop, and will also handle cylindrical work within its capacity. For this purpose, a pump and tank for water supply have been provided. An automatic feed having six changes is provided for cylindrical work, and these can be reversed within very close limits allowing work to be ground to a shoulder. One of the chief aims has been to make the machine substantial so as to eliminate all possible spring. The spindle head has a 2-step cone securing two feeds for the wheel in any desired position with relation to the work to be ground. This head can be swiveled to any desired angle and is graduated.

The table has a bearing its entire length on the slide, is graduated and can be turned clear around and clamped in any position on the slide. A scale embedded in the slide enables quick and accurate measurements, and the amount of taper per foot. This taper adjustment is very delicate, being secured by a worm and wheel.

The headstock may be swiveled in any angle in the vertical or horizontal plane and clamped in any position. The tailstock has a compensating center and is actuated by a lever which makes it very convenient to withdraw center from work. The vise when mounted on the headstock swivels in any angle and holds circular or taper work. The tooth rest is universal in construction, having a micrometer adjusting nut for accurate setting in any position. A swinging hanger alters the distance between the main countershaft and the drum countershaft, tightens the belt or allows it to hang loosely on pulleys, doing away with a loose pulley. One-half turn of handle causes the hanger to swing forward enough to stretch the belt tight and *vice versa*, a brake shoe stopping the shaft instantly as shown in Fig. 2. The loose pulley on the main countershaft is shown in Fig. 3, with an oil reservoir in the reservoir.

The table has a feed of 16 inches in length and 8 inches across, with a vertical movement of 7½ inches. It swings 9 to 12 inches and takes in 24 inches between centers. It is made by the Oesterlein Machine Company, Cincinnati, O.

UNIVERSAL CUTTER GRINDER

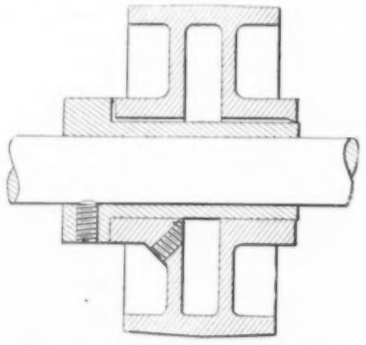


FIG. 2. LOOSE PULLEY ON MAIN COUNTERSHAFT

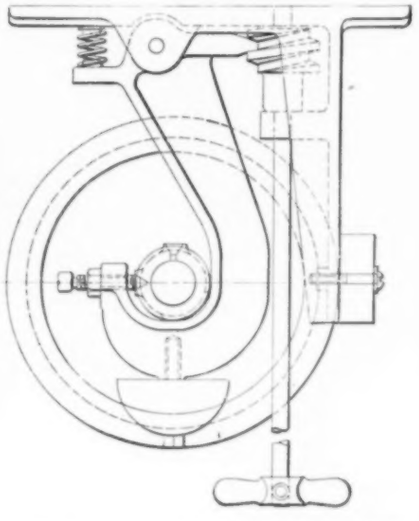


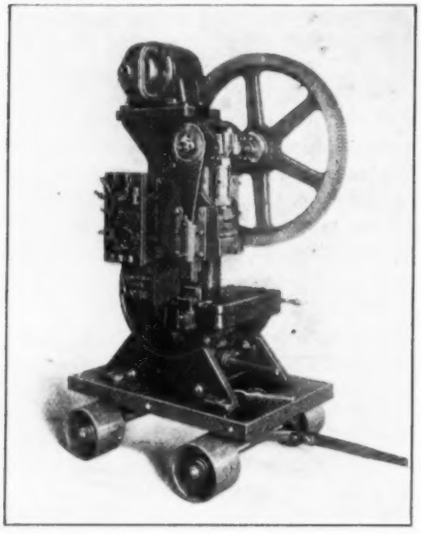
FIG. 3. LEFT SIDE OF DRUM COUNTERSHAFT

A Portable Electric Trimming Press

The illustration shows a portable trimming press which is one of the latest tools to be equipped with electric motors. This tool is extensively used in drop-forge shops. In many shops which are equipped only for large work it is desirable to make small forgings from time to time. Such cases may not be of often enough occurrence to warrant the installation of special trimming machinery and still the trimming cannot be satisfactorily done by the larger machines.

Where small work is done by the larger presses it is either necessary to put small trimming dies in a large trimming press or to set up a small trimming press beside the drop hammer. Neither of these methods is economical nor satisfactory. As the press shown is self-contained and mounted on a truck it may be readily taken from any part of the shop and put where it is needed.

Owing to the fact that any machine moved around the shop is apt to collide



A PORTABLE ELECTRIC TRIMMING PRESS

with other machines while being moved, the truck of this press is made to extend farther out than any other part. This entire absence of overhanging parts gives the press the added advantage of being less in the way, as from its nature it must necessarily operate in aisles and between other machines.

When this trimming press has been wheeled on its truck to the place in which it is to work the only preparation necessary is to connect the motor to the electric circuit.

The starting switch and control apparatus are mounted on the frame of the machine in a position easily reached by the operator.

The trimming press shown is manufactured by the E. W. Bliss Company, Brooklyn, N. Y., and the driving motor by the General Electric Company, Schenectady, New York.

The Pittler Turret Lathe

This is an interesting example of German design in turret machinery. It has a double friction head, a quick-change feed box, and it will be noted that all gearing is completely inclosed. There is also the Fox chasing bar, but the distinctive feature is the turret which is arranged to hold 16 tools, each having an independent stop, and instead of having a cross-slide for either head or turret, the turret head itself is revolved to move the facing tool across the work.

The turret head is on a shaft which is supported by two long bearings, and as the outer end of the turret head carries gear teeth, it is easy to turn the tool across any work to be faced by the hand-operated pinion shown. In some instances on comparatively large work it is customary to turn the outside of a flange by revolving the turret carrying the tools to

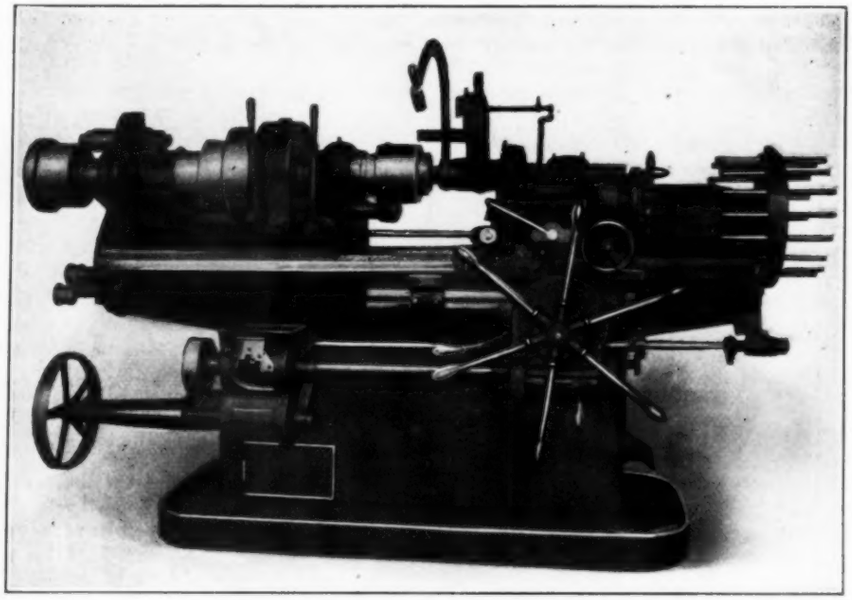


FIG. 1. PITTLER TURRET LATHE

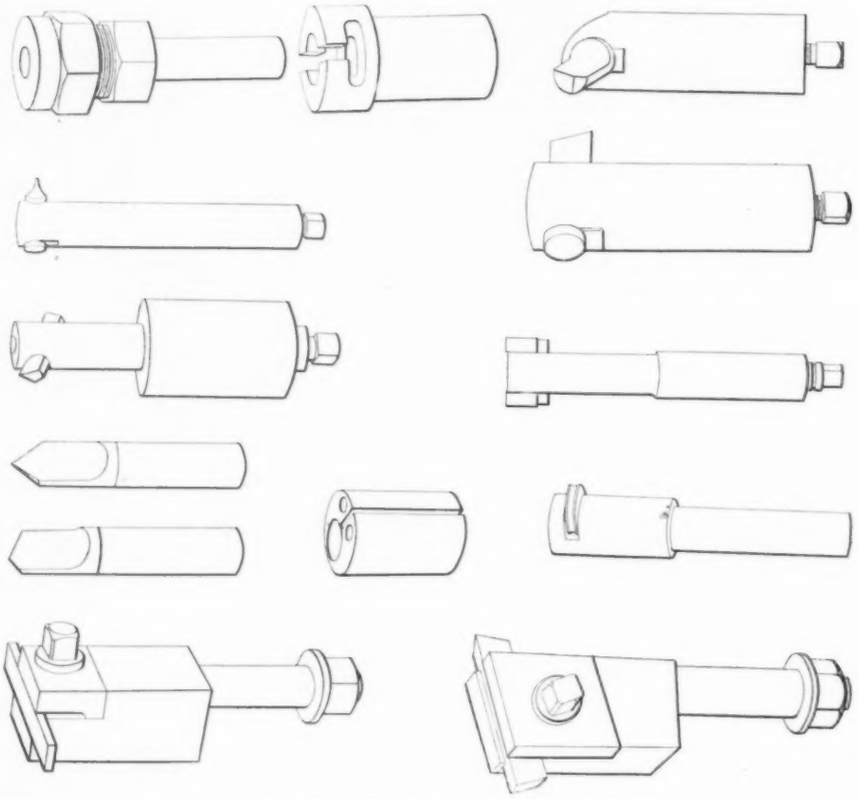


FIG. 2. STANDARD TOOLS FOR PITTLER LATHES

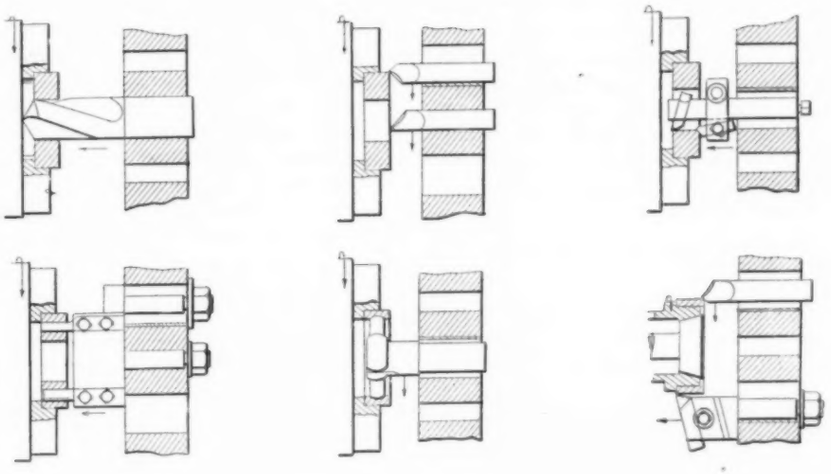


FIG. 3. WORK OPERATIONS SHOWING TOOLS USED

the left, and where two tools are used, as is often the case, one-half a revolution of the turret turns the outside of the flange.

Very simple tools are used, as can be seen in Fig. 2, while Fig. 3 gives a series of operations, taken from one of their work sheets, which shows not only the tools, but also the method of handling the work.

These are made by Leipziger Werkzeug-Machinenfabrik, Leipzig-Wahren, Germany.

Hexagonal Milling Machine

This has been designed for milling the hexagonal portions of valve bodies, hex nuts or other work. It carries three pairs of straddle mills, driven through bevel gearing by the central shaft, while the work is carried on four work spindles on the outer or revolving table. This leaves one spindle free for changing work while the others are at work.

The outer table is in the form of a ring resting on ball. The inner table carries a large gear into which meshes a gear on each work spindle, so that when the outer table is revolved to bring the work under a different pair of milling cutters, the work itself is turned to present new surfaces to the cutters, being locked into correct positions by a spring pin index.

On the shaft *A*, driving the cutters through the bevel gearing, is a spiral gear which drives the worm and worm wheel above it as seen in Fig. 1. This is connected by a clutch to the large cam on the outer end above the driving pulleys and this feeds the table and work up to the cutters through the lever arrangement shown. The hight of the table can be adjusted a distance of 8 inches independently of this by the hand-operated worm *C* through the worm wheel and internal screw shown.

It handles work as large as can be done

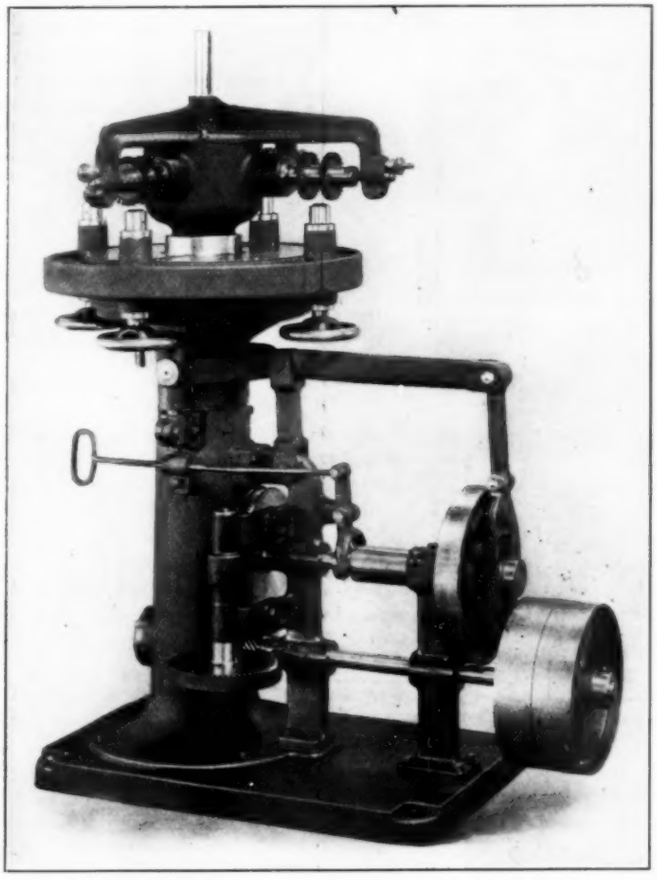


FIG. 1. BEMIS HEXAGONAL MILLING MACHINE

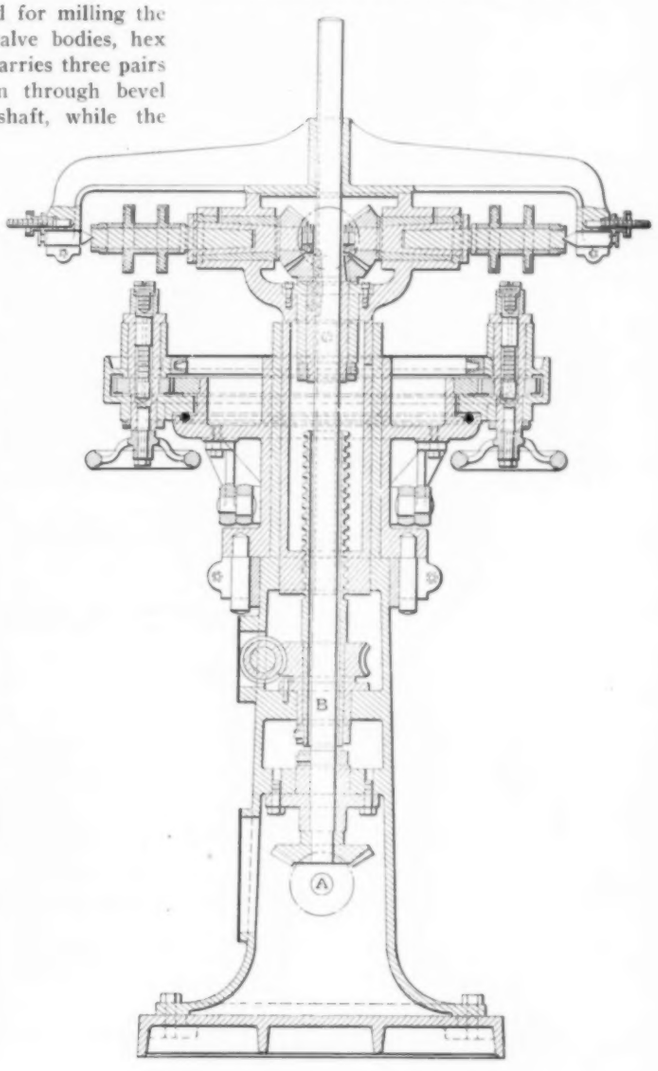
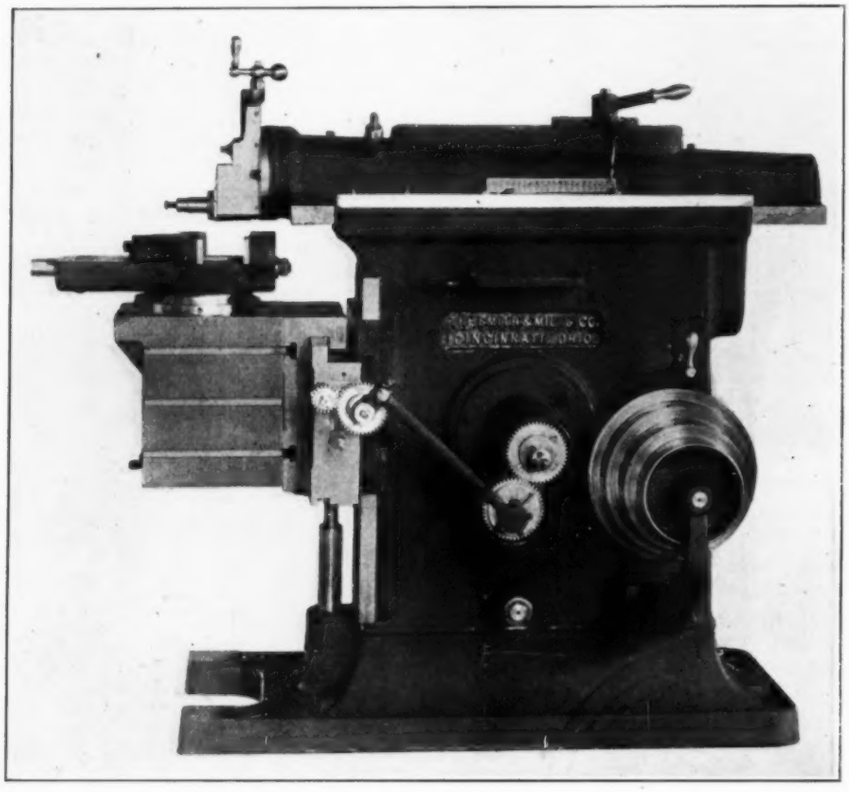


FIG. 2. CONSTRUCTION OF HEXAGONAL MILLING MACHINE

with a 3-inch mill and on ¾-inch nuts has milled 240 per hour. It is made by Edgar W. Bemis, Worcester, Mass.

A Back-geared Crank Shaper

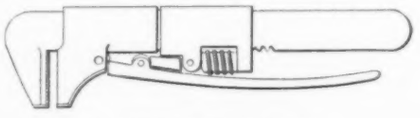
The illustration shows a 20-inch back-geared crank shaper built for high speed and heavy duty. This machine is built in three sizes, viz., 16-, 20- and 25-inch stroke. The cutting speed is 40 feet per minute. Eight speed changes are available. On the 16-inch machine these speeds vary from 6.21 to 157.15 strokes per minute; on the 20-inch machine from 7 to 100.8 strokes per minute, and on the 25-inch machine from 6.75 to 80 strokes per minute. The 25-inch machine will carry a cut 1 inch deep, 3/16-inch feed with the stroke set at 18 inches. At this rate the machine will remove a little over 15 cubic inches of metal per minute. These shapers are built by the Smith & Mills Company, Cincinnati, Ohio.



A BACK-GEARED CRANK SHAFT

A Toggle-grip Wrench

This wrench combines the regular screw adjustment of the standard wrench, and in addition has a toggle grip which holds it firmly against the nut or bolt head. This is secured by having the gripping jaw independent of the sleeve which is operated by the nut, but connected to it by the toggle shown. In use the lever is raised a little and the screw adjustment made to nearly close the jaws on the object; then a pressure on the lever straightens the toggle and locks the jaw on the nut. This not only prevents slipping and marring a nut, but also allows it to be used as a hand vise, holding the piece firmly between the jaws. It is comparatively simple, having little more to it than an ordinary wrench, and while designed particularly for automobilists,

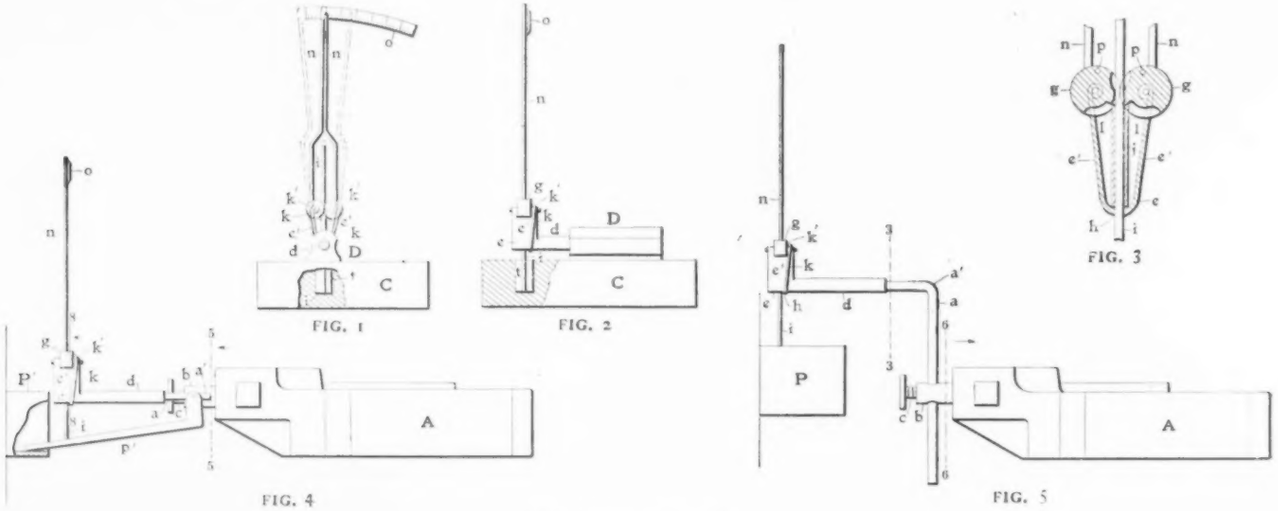


A TOGGLE-GRIP WRENCH

should be equally useful to the machinist in many places. It is made by the Lever Company, 45 Cedar street, New York.

The Ennis Indicator

This is a very sensitive indicator and is made on somewhat different lines than usually employed. Figs. 1 and 2 show the indicator used as a depth gage with the point pressed to the bottom of the drilled hole. The operating mechanism is shown in Fig. 3 which is considerably enlarged and shows the indicating arm with small cams at the lower end. The indicating rod or pointer passes down between grooves in these cams, inside a sleeve which is a snug fit and which acts on the cam points at its upper end, and resting between them and the spring which controls the movement of the two arms. As the pointer is forced up against the cams they throw the arms apart and indicate



THE ENNIS INDICATOR

the distance on the scale above, as in Fig. 1. The scale being formed on one arm and the pointer on the other, doubles the indication and in this way a comparatively coarse division of the scale reads to 1/1000 inch.

Fig. 4 shows an application of this instrument to internal work by the use of a simple indicating arm which hinges on the face of the instrument and projects into the hole under the indicator rod. The end of the rod resting on this shows any variations in the running of the work. Fig. 5 shows this applied to the outside of cylindrical work, and other applications can be readily understood. This is the invention of Benjamin F. Ennis, 214 West Beard avenue, Syracuse, N. Y.

A Hand Magnet

This device shown in the half-tone weighs only about 7 pounds but is capable of lifting castings of from ten to fifteen times its own weight.

The magnet is designed for operation

A HAND LIFTING MAGNET

on 110-volt, direct-current circuits and is furnished with drop cord and attachment plug so that it may be readily attached to any ordinary lamp socket. The push-button mounted on top of the magnet and operated by the thumb closes the circuit to the coils and makes the magnet operative. On releasing the button the poles become demagnetized and the load is released.

In machine shops it is used for clearing chips and borings out of the machinery or removing them from parts of the work not easily accessible, as for instance from the bottom of a deep cylindrical casting. Dropped tools, bolts, boring bars, etc., are easily recovered with the aid of the magnet from places from which it would be difficult to fish them by ordinary means. Many other uses will suggest themselves for this handy little magnet which is made by the Cutler-Hammer Clutch Company, Milwaukee, Wis.

Thread Milling Attachment for Bench Lathe

The illustrations herewith show front and rear views of a thread-milling attachment for the Cataract precision bench lathe, manufactured by Hardinge Brothers, Chicago, Ill. All the standard attachments for the lathe can be used in connection with the threading device, such as the universal countershaft for cutter speeds; the screw-cutting attachment *A*, Fig. 1, for feeding for the pitch; the spindle nose for driving either left- or right-hand and reducing the speed by using a worm wheel, as shown; the regular slide rest upon which is mounted a standard quill with a cutter spindle *B* that is interchangeable in various blocks *C* made to suit the different pitches and diameters. The worm for driving the worm wheel is driven by a belt from the regular counter cone pulley to the cone pulley *D*, Fig. 2, carried by a bracket attached to the standard bed for the chasing attachment, and the miter gears drive the worm as indicated. An automatic stop is provided in the form of a simple adjustable strip *E*, Fig. 1, which is attached to the top slide of the slide rest by a couple of screws and, as the slide travels toward the head, strikes against the trip *F* and disengages the worm. The attachment can be used for cutting worms and threaded parts for electric meters and similar instruments, making taps, milling square threads, etc.

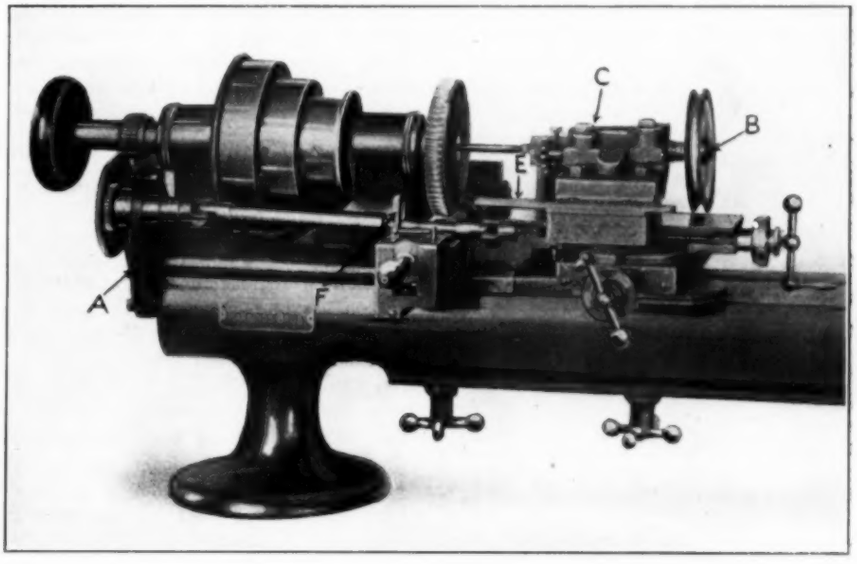


FIG. 1. BENCH LATHE WITH THREAD-MILLING ATTACHMENT

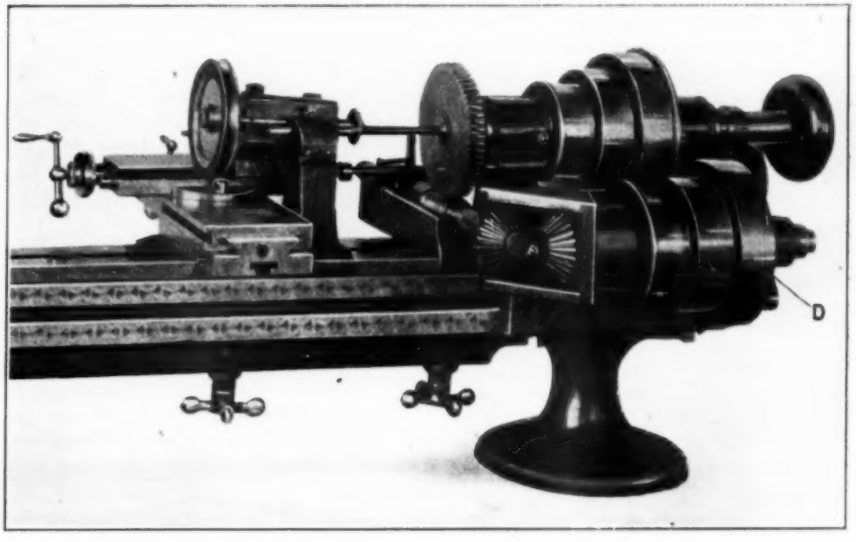
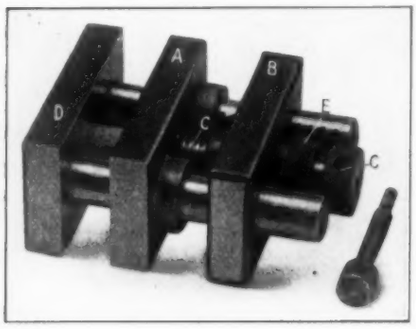


FIG. 2. BENCH LATHE WITH THREAD-MILLING ATTACHMENT

Quick Acting Toolmakers' Vise

The half-tone shows a handy toolmakers' vise for use on the drill press, miller, bench plate, etc. As will be seen, the movable jaw *A* and the block *B* in which is formed the nut for the nurled-head screw *C*, slide on a pair of longitudinal studs, which are secured in fixed jaw *D*. These studs are provided on their inner surface with a series of ratchet-shaped teeth, which are adapted to be engaged by a locking disk rotated by nurled projection *E*. By rotating this a fraction of a turn the block *B* and jaw *A* are unlocked on the studs and may be slid quickly to any position required, after



QUICK-ACTING TOOLMAKERS' VISE

which a slight turn of *E* again locks the sliding jaw and nut fast to the studs. The screw *C* is then turned to clamp the work tight between the jaws. The nurled head of this screw is provided with six pin holes and the nurled-head pin shown may be employed for setting the jaw up tight. A longitudinal hole drilled in the body of the vise screw forms a chamber in which the pin is ordinarily placed when not in use.

The vise illustrated has all parts finished and hardened. The size shown has jaws measuring 3x1¾ inches, and opening 2 inches. It is made by the Mutual Machine Company, Hartford, Conn.

Rapid Cutting-off on a Hacksaw

An interesting test was recently made in the plant of the Diamond Saw and Stamping Works, Buffalo, N. Y., with their new high-speed power hack saw. One blade was tried on a 5-inch round bar of hammered axle steel, making the first cut through this steel in 25 minutes, the second cut in 28 minutes, and so on until the ninth cut was completed in 42 minutes. The machine was run at a speed of 106 strokes per minute and was used with a lubricant of soda and water. A second test on the same bar gave practically the same results, indicating that these results represent a fair average.

Meeting of the National Gas and Gasolene Engine Trades Association

The first regular meeting of this association has been called for February 9 at the Auditorium Hotel, Chicago. The date named has been selected because of the automobile show to be held in Chicago the same week and the sessions of the association have been arranged for the daytime only in order to leave the evenings open for attendance at the exhibition. Several papers of interest to the trade are promised.

In France there seems to have been considerable progress made in the matter of mechanical bread-kneading for recently there was held in the city of Lyons an exhibition for the express purpose of bringing to the public attention bread-making machinery. Thirty mechanical devices for kneading bread by power were exhibited, all of which were of French invention with the exception of three. The machines are capable of kneading from 300 to 1000 pounds of bread per hour, and are used in nearly every bakery in France.

The Construction and Efficiency of the Manly Drive

The Manly drive is a device for transmitting power by hydraulic means from one revolving shaft to another, with the object of securing any desired speed of the driven shaft, either forward or backward, without changing the speed or direction of motion of the driving shaft, and to transmit the power to a shaft which is either in line with the driving shaft or which lies at any angle to the driving shaft and separated from it.

It consists of a multi-cylinder pump with variable stroke which is attached to the driving shaft, and one or more multi-cylinder motors having a fixed stroke, which are attached to the driven shaft, together with pipe connections or passages between them for transmitting the working fluid. The various cylinders, both of the pump and motors, radiate equidistantly from a central crank chamber, and the pistons or plungers are connected to a single crank pin, which is common to all. The fluid used is ordinary machine oil, the lubricating qualities of which, and its freedom from danger of freezing, admirably fit it for such a purpose. When once filled the oil is used over and over again, being in continuous circulation from pump to motor through one set of pipes or passages and back again from motor to pump through another set.

The illustrations show in outline the leading features of the arrangement. Fig. 1 gives the location of the cylinders around the central crank chamber, five being used in this case, all being 2½ inch bore, the pump 1½ and the motor 3 inch stroke. Fig. 2 is an elementary sectional elevation showing the cylinders and valves of both pump and motor, and the pipes forming the connection between them. *A* represents the plungers, and *B* the valves of the pump. Connection between the two is made by passages leading from the head ends of the pump cylinders to the

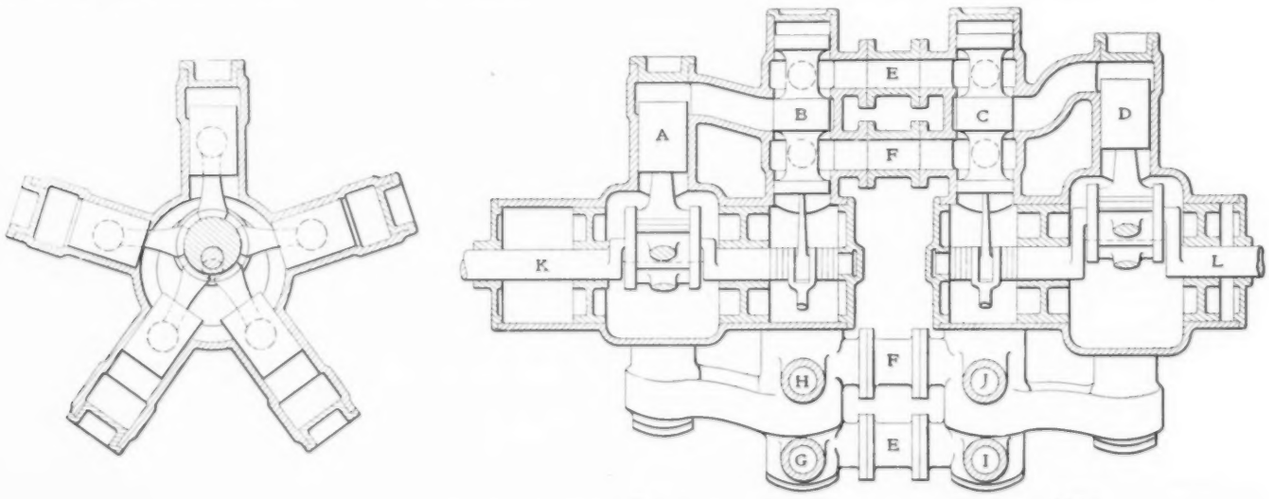
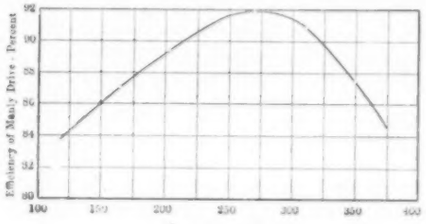


FIG. 1. END AND LONGITUDINAL SECTIONS OF MANLY DRIVE

centers of the corresponding valve chambers. *C* represents the valves, and *D* the plungers of the motor. Here the passages between the valve chambers and the plunger cylinders lead from the center of the valve chambers to the head ends of the motor cylinders. The corresponding ends of the two valve chambers are connected by the pipes *E* and *F*. One pipe carries the oil in one direction, and the other pipe returns it in the opposite direction. The outer ends of the five valve chambers of the pump are connected by the circular passage *G* and the inner ends by the circular passage *H*. Likewise the five valve chambers of the motor are connected by the circular passages *I* and *J*. In this elementary diagram the two shafts (both driving shaft *K* and driven shaft *L*) are shown in the same line, although disconnected. It will be readily seen that the two shafts may occupy any angular position with reference to each other, and any distance apart, the connecting pipes being arranged accordingly. The largest diameter is 24 inches and the pump is 30 inches

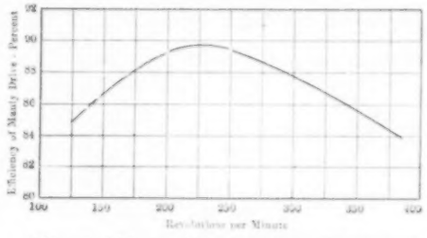


Oil 132 to 135 degrees. Power supplied 14.3 to 14.87 horsepower, speed 750 to 760. Speed of driven 350 to 163 revolutions per minute. Constant power delivered.

DIAGRAM 3. CONSTANT DRIVING POWER AND SPEED. CONSTANT POWER DELIVERED AT VARYING SPEEDS. EFFICIENCY 87 TO 91.9 PER CENT.

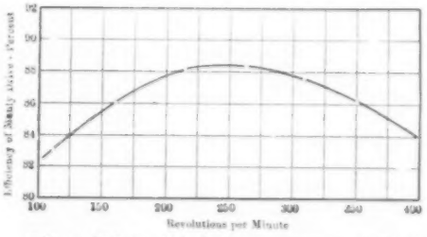
long over all. The pump and one motor hold 5 gallons, while another motor would add 2½ gallons, this particular case consisting of one pump and two motors, one for each driving wheel of a heavy truck.

The stroke of the pump may be varied at will; that of the motor is fixed. The variation of pump stroke is accomplished by a crank on which is mounted an eccentric bushing. By revolving the central bushing with reference to the crank its center line is brought into alinement with the center of the shaft, and when this position is reached no reciprocating motion is communicated to the pump plungers. When the pump is running at full stroke the motor operates at the highest speed. By varying the pump stroke and thereby the velocity of the oil in circulation, the motor runs at a speed which is just in proportion to the amount of oil that passes through it. Any desired rotative speed can therefore be secured and maintained. For reversal, the pump stroke first passes through the zero point. Then the valves change, and the oil is simply pumped in the opposite direction through the ports and pipes. Referring to Fig. 2, when the motor is going forward, pipe *E* furnishes a supply to the motor transmitting the oil under pressure from pump to motor, while pipe *F* returns it from motor to pump, thereby answering the purpose of an exhaust pipe. When the motor goes backward pipe *F* becomes the supply pipe under pressure, and pipe *E* changes to the exhaust pipe; the direction of circulation through the connecting pipes being completely reversed. In case of a sudden check in the speed or a quick reversal, the momentum due to running in one direction is taken up in the device itself. A safety valve, set at 2000 pounds per square inch, opens a bypass when there is an over-pressure, this acting as a cushion to prevent injury to the machine.



Oil at 115 to 120 degrees. Power supplied 14.43 to 14.87 horsepower. Speed of driving shaft, 750 to 760. Speed of driven varied as above from 139.7 to 363 revolutions per minute.

DIAGRAM 1. CONSTANT SPEED OF DRIVER-VARIATIONS IN DRIVER. EFFICIENCY 85.3 TO 89.4 PER CENT.



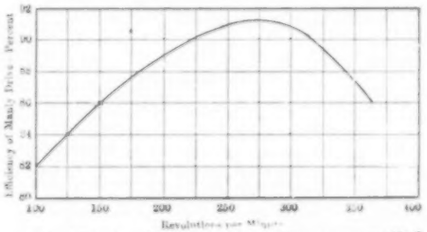
Oil at 122 to 130 degrees. Power supplied from 14.3 horsepower at 750 revolutions per minute, to 4.72 horsepower at 730 revolutions per minute. Driven shaft from 352 to 112 revolutions per minute.

DIAGRAM 2. VARIABLE DRIVING SPEED; CONSTANT DRIVEN SPEED. EFFICIENCY 83.1 TO 88.4 PER CENT.

The rotation of the crank bushing from the position of maximum stroke to the no-stroke point, is accomplished by the use of an auxiliary piston, lying parallel to the shaft, and supplied with power from the fluid pressure of the pump, and this piston operates on the bushing through appropriate mechanism. It is under the control of a pilot valve, which is moved at will by means of a hand lever. By simply moving this lever from one end of its throw to a central position, the speed of the motor shaft is varied from its maximum speed to a condition of absolute rest, and by moving the lever to the other end of its throw the motion is reversed and any speed is secured ranging from zero to a maximum speed in the reverse direction. Meanwhile, the driving shaft continues to run at constant speed, whatever the speed or direction of motion of the driven shaft.

The speed-controlling feature serves a most important purpose when applied to vehicles, such as automoblies, railroad motor-cars, power boats and elevators. When the motor comes to absolute rest, the pump stroke being reduced to zero, no motion of the motor is permissible in either direction until the adjustment is changed so that the fluid again begins to flow from pump to motor. Its effect at such times is that of a brake applied to the wheels, though much more positive and reliable. The importance of the brake feature can hardly be overestimated when it is remembered that all the effects as to varying speed, reversal of motion, and brake action are brought about by the movement of a single hand lever.

The efficiency is indicated by the four diagrams, taken under different conditions as indicated in each case. Though this shows less loss than would naturally be expected, the fact that lubricating oil is being forced between all bearing surfaces, and varies with the work done, accounts for the high efficiency shown. While it



Oil 134 to 137 degrees. Power supplied 14.3 horsepower at 350 revolutions per minute of driven to 4.60 horsepower at 105 of driven. Driving speed, 740 to 760.

DIAGRAM 4. CONSTANT SPEED OF DRIVER. VARYING POWER OF DRIVER AND VARYING POWER AND SPEED OF DRIVEN. EFFICIENCY 81.6 TO 90.9 PER CENT.

seems at first glance to require considerable mechanism, it must be remembered that it accomplishes what we desire and need.

Convention of the American Anti-Accident Association

The coming convention of this association already noted in these columns is to be held in the Y. M. C. A. hall, 215 West Twenty-third street, New York City, on the afternoon and evening of Thursday, February 11, 1909. Employers, employees and the general public are cordially invited to attend, the afternoon session being the more important for women. The following papers comprise the program as arranged at the date of writing:

AFTERNOON SESSION

Hoodlumism in Holiday Observance, by Mrs. Isaac L. Rice, president of the Society for the Suppression of Unnecessary Noise, New York City.

Railway Accidents, by Edward Bunnell Phelps, editor the *American Underwriter*, New York City.

Fire Wastes through Carelessness, by C. M. Goddard, president of the National Fire Protection Association, Boston, Mass.

The Child, and Accidents of our Unbridled Laxity, by Thomas D. West, president of the association, Sharpsville, Penn.

EVENING SESSION

Museum of Safety and Sanitation, with lantern slides, by Dr. William H. Tolman, director of the New York City Museum of Safety Devices.

Industrial Accidents and the Inventors, by Joseph J. O'Brien, member of International Congress of Inventors, Washington, D. C.

Safety Devices in the Machine Shop and Manufacturing Establishments, by Prof. John E. Sweet, Syracuse, N. Y.

Wage Workers Accident Insurance and Compensation Fraternity, by Thomas D. West.

A Milling Fixture for Square and Hex Heads

BY J. R. WEANER

Being foreman of a tool room for a large concern and seeing the need of a milling fixture to mill square heads on different size screws faster than the old way of indexing with a dividing head, I designed and made the jig shown in Fig. 2, and it proved very successful.

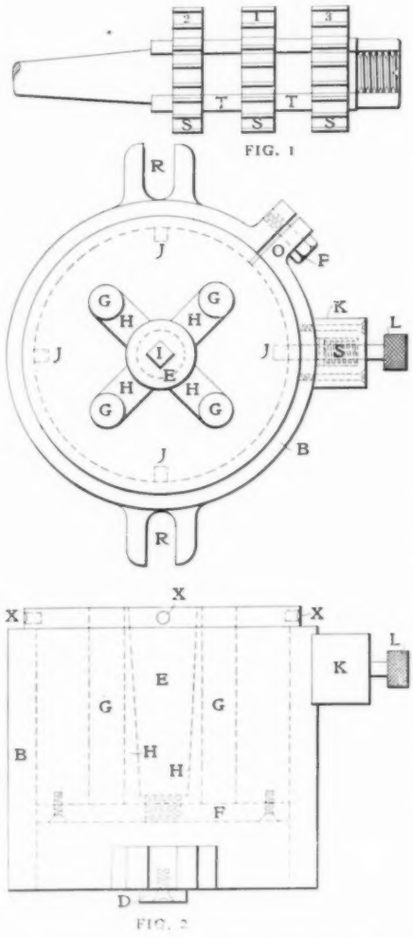
The base *B* is made of cast iron, bored to receive *C* and has slots planed on the bottom to receive tongues *D* which fit in slots of the milling table. *C* is also cast iron with a taper hole in the center to receive the plug of machine steel *E* which has a thread on the small end to screw into *F*.

F is a steel plate fastened to *C*. Four equally spaced holes *G* are drilled in *C* the same diameter as the work to be milled. It is always advisable to make the holes *G* the size of the largest screws milled, then they can be bushed down to the smallest size by sawing a 1/16-inch slot in the bushings so they will pinch the work. After these holes are drilled the parts are slotted out for the steel keys *H* to fit in.

It can now be seen that by placing a T-wrench in *I* and turning *E* to your right will press the keys *H* forward and tighten all the four screws at one time.

The next thing is to divide *C* and drill it for the index pin *L*. If a square head is wanted *C* is drilled in four places at 90 degrees marked *J* but if a hexagon head is wanted *C* is divided into six parts. *K* is fastened with four 5/16-inch flat-head screws to *B*. *K* holds the indexing pin *L* which fits in holes *J*. A spring *S* forces the index pin *L* in the holes *J*. The lug *O* is cast on *B* and a 1/16-inch slot is sawed three-fourths the hight of the casting *B*. Then screw *P* is put in it; the object of the lug *O* is to bind the casting *B* tight on *C* while milling the screws.

Four tommy holes marked *x* on the top collar of *C* are drilled 3/8 inch diameter so that *C* can be turned by using a 3/8-inch pin 6 inches long. *R* are lugs to receive bolts to fasten the jig on the table. Three cutters are made all the same diameter and placed on the milling arbor as shown in Fig. 1. The collars between them marked *T* are turned the width of the work; in this case they are 3/4 inch long. Cutter No. 1 has to be made the



A MILLING FIXTURE FOR SQUARE AND HEX HEADS

proper width to take the required amount of stock off the screw heads; 2 and 3 can be made any width.

In milling; four screws are fastened in *G* and cutter 1 runs between them or over top of *E*. Cutter 2 mills the outside edge of the screw on the inside row and cutter 3 on the outside edge of the outside; now by pulling out of *L* and turning *C* a half turn and milling through them again you have four screws finished.

We had 1600 1/4-inch screws to mill, with a boy on the job. His average was 24 per hour. This was a great improvement over the old way.

Business Items

The Wagner Electric Manufacturing Company has opened a sales office in the Trust building, Charlotte, N. C.

The McMullen Machinery Company, 58 South Ionia street, Grand Rapids, Mich., has been incorporated, capital $15,000, for the purpose of establishing a wood-working machinery department.

Business Opportunities

The Geneva (N. Y.) Cutlery Company wil erect a two-story addition.

The Vincennes (Ind.) Bridge Company is building an addition to plant.

The Reading (Penn.) Iron Company has about completed plans for new pipe mill.

Dorman, Hufford & Co., Boston, Mass., are to build a canning factory at Carmel, Me.

The Syracuse (N. Y.) Safe Company has purchased site on which plant will be erected.

The United States Radiator Company, Dunkirk, N. Y., will erect an addition to foundry.

It is reported that the St. Joe Motor Car Company, of Elkhart, Ind., will move to Hutchinson, Kan.

The Chicago, Milwaukee & St. Paul Railroad will build a large new roundhouse at Aberdeen, S. D.

The Snyder Stave Company, Dermott, Ark., will erect new plant to replace the one recently burned.

E. S. Ingersoll, whose paper mill at Seneca Falls, N. Y., recently burned, is preparing to rebuild same.

The plant of the Xenia (Ohio) Board and Paper Company was destroyed by fire. Loss, about $75,000.

The Buffalo Pitts Company, Buffalo, N. Y., manufacturing traction engines, etc., is erecting an addition to plant.

The Erie (Penn.) Forge Company has awarded contract for the construction of three open-hearth buildings.

The Monumental Paper Box Company, Baltimore, Md., has awarded contract for construction of building.

It is said that the Jas. F. Powers Foundry Company, Elkton, Md., is considering the addition of a steel casting plant.

John Howland, water and light commissioner, Austin, Texas, would like catalogs of machinery suitable for small machine shop.

The Wheeling (W. Va.) Mold and Foundry Company contemplates the erection of a 150-ton iron furnace to cost over $200,000.

The Baltimore (Md.) Metal Stamping and Manufacturing Company will equip plant for the manufacture of buckets, cans, etc.

The Lamb-Fish Lumber Company, Charleston, Miss., is arranging for the erection of box factory, veneering plant and planing mill.

The blacksmith, wood and machine shop of Joseph W. McCormick, Providence, R. I., was burned, causing a loss of about $10,000.

The Chamber of Commerce, Dayton, Ohio, is negotiating with the National Cutlery Company, of Philadelphia, to locate in Dayton.

The Belton & Temple Traction Company will enlarge car barns and repair shops at Temple, Texas. W. G. Haag, Temple, superintendent.

The Norfolk & Western Railway Company is starting the erection of railway shops at Williamson, W. Va. C. S. Churchill, Roanoke, Va., is chief engineer.

The McCue Company, Hartford, Conn., is erecting a new factory for manufacturing its gears, automobile axles, etc., as well as complete automobiles.

Plans have been approved by the Erie Railroad for double-tracking its Sharon branch between New Castle and Terrana and for the building of a new roundhouse to cost $750,000.

The Humane Horse Collar Company, of Omaha, Neb., is moving its plant to Chicago Heights. The company makes steel and leather horse collars and will need some new machinery.

It is reported that the Multonomah Manufacturing Company, Portland, Ore., will establish a plant in Fort Worth, Texas, for the manufacture of farm implements and traction engines.

The H. E. Mills Manufacturing Company, Syracuse, N. Y., whose plant burned some time ago, has decided to rebuild. The company manufactures foundry machinery and core compounds.

The Anti-Frictional Bearing Company, of Tampa, Fla., incorporated with $100,000 capital, will soon commence erection of a plant at Atlanta to manufacture automobiles, street wagons, trucks, etc.

The National Gear Wheel and Foundry Company, Pittsburg, Penn., will erect a new building, which will contain pattern shop, storage department, etc. This will permit enlargement of foundry, where pattern shop is at present.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., February 23 for car wheels, snatch blocks, band saws, tees, valves, test gages, leather belting, etc., as per Circular No. 492.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., February 11 for steam pumps, electric motors, wood-boring machine, packing, copper tubing, chain, forges, vises, wrenches, hammers, nails, screws, nuts, washers, etc., as per Circular No. 493.

The Neidich Process Company, S. A. Neidich, president, Burlington, N. J., contemplates extensive enlargements and improvements in its plant. A two-story reinforced concrete building with basement, 64x64, is to be erected this spring. F. A. Waldron, of 37 Wall street, New York City, has been retained as architect and engineer.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: February 9—Bolts and nuts, drills, taps (schedule 864), hack-saw blades (schedule 863). February 16—Galvanizing furnaces (schedule 855), motors (schedule 857), plate planing machine, punching and shearing machine, drilling machine (schedule 856). February 23—Iron cement (schedule 867), set screws (schedule 869), steel (schedules 869, 870), lubricating graphite, brass pipe (schedule 870). March 2—Motor hoists (schedule 873).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: Feb. 16—pneumatic emery grinder, grinding machine (schedule 882), augers (schedule 884), circular saw blades, boring tools, spring collets, drill sockets (schedule 882), bolts and nuts (schedule 894), crucible steel (schedule 892); Feb. 23—centrifugal pumps (schedule 899), ventilating blowers, steel-plate fans (schedule 888), blower fan (schedule 887), boring mill (schedule 889), bolt cutter (schedule 898), molding machine (schedule 886); March 2—pneumatic drills, steel-boiler plates (schedule 896).

New Incorporations

The Charlotte (N. C.) Tanning Company has been granted charter. Capital, $125,000.

B. Fleigle Company, Chelsea, Mass., incorporated to manufacture and sell sewing machines. Capital $25,000. B. Fleigle, Roxbury, president.

The Morgan Electric Plating and Manufacturing Company, Pittsburg, Penn., has been incorporated to do electro-plating of metals, etc. Capital, $25,000.

The Piper-Rust Iron Company, Birmingham, Ala., has been incorporated with $12,000 capital to establish iron foundry. C. E. Piper, president; S. N. Rust, vice-president.

The Pilsen Sash and Door Company, Chicago, Ill., has been incorporated with $25,000 to manufacture sash, doors, etc. Incorporators, Wm. Knourek, V. Sanders, Frank Schindelar.

The Seymour Locomotive and Equipment Company, Hattiesburg, Miss., has been incorporated. Capital, $30,000. Incorporators, W. E. Seymour, Hattiesburg, and William Seymour, Chicago.

The Machinery Development Company, New York, incorporated to buy and sell patents, manufacture machinery, etc. Capital, $10,000. Incorporators, B. F. Spellman, M. E. Van Dine, Albert Cohn.

The U. S. Coal Saver and Smoke Consumer Company, Augusta, Me., has been incorporated to manufacture and sell smoke saving devices. Capital, $1,000,000. J. Berry, Augusta, president and treasurer.

The Bingham Manufacturing Company, Souht Berwick, Me., has been organized for the purpose of carrying on a general machinery and hardware business. Capital $100,000. Fred. A. Hubbs, president.

W. H. Stavenhagen Company, Union, N. J., has been incorporated to manufacture lamps, electroliers, gas fixtures, etc. Capital, $10,000. Incorporators, W. L. and B. L. Stavenhagen and Albert Pritzfelder.

The Brighton White Metal Company, New Brighton, Penn., has been formed to manufacture babbitt metal, solder, etc. W. D. Berry, of the Brighton Brass and Bronze Company, is at the head of the new concern.

The Campbell Belting Company, Hoboken, N. J., filed articles of incorporation to manufacture machinery and belting in Baltimore. Capital, $50,000. Incorporators, A. L. Campbell, Joseph Newberger, J. G. Nagangast.

The Instantaneous Electric Water Heater Manufacturing Company, Newark, N. J., has been incorporated to manufacture electric water heater. Capital, $25,000. Incorporators, J. A. Sheppard, T. P. McGrane and J. G. Allen.

Expanded Metal Company of Philadelphia has been incorporated at Camden, N. J., to manufacture expanded metal and specialties of wood, metal, etc. Capital $12,000. Incorporators, J. S. Merritt, F. T. Magee, Stephen Morris.

Trade Catalogs

Fay & Scott, Dexter, Me. Catalog describing lathe turrets. Illustrated, 16 pages, 4x9 inches, paper.

The Cleveland Twist Drill Company, Cleveland, O. Folder illustrating and describing Peerless high speed reamers.

The Corbett Supply Company, Trenton, N. J. Catalog of general mill supplies. Illustrated, 520 pages, 6x9 inches, cloth.

The Emerson Electric Manufacturing Company, St. Louis, Mo. Catalog of alternating current fans. Illustrated, 5x8 inches, paper.

General Electric Company, Schenectady, N. Y. Bulletin No. 4638 entitled, "A Guide to the Design of Medium and Small Capacity Central Station Switchboards." Illustrated.

Landis Tool Company, Waynesboro, Penn. Catalog describing universal and plain grinding machines, gap, crank and internal grinding machines. Illustrated, 80 pages, 6x9 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

Test indicators. H. A. Lowe, Cleveland, O.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

For heavy engineering specialties to manufacture on royalty. Box 878, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machinery designed by mechanical engineer. Details and tracings. "H. C.," AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Wanted—By an established firm, to buy patterns and designs of successful two-cycle gas engines. Ones now on the market with a good record of past sales the preference. Box 890, AMERICAN MACHINIST.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Tool room foreman desires change; first class on tools for adding machines, cash registers and typewriters. Box 764, AM. MACH.

INDIANA

Superintendent—Practical machinist and toolmaker. Wide experience handling men and producing results. Age 38. Now employed. Will go anywhere. Box 877, AMER. MACH.

MASSACHUSETTS

I wish to correspond with any company desiring the services of a progressive and up-to-date manufacturing superintendent. Box 897, AMERICAN MACHINIST.

Wanted—By experienced mechanic, position as foreman of tool room or general foreman of high-class machine shop. Ten years' experience on small and medium interchangeable work. Will locate anywhere for good position. Box 892, AMERICAN MACHINIST.

MICHIGAN

Superintendent, up on rapid duplication of parts in manufacture of gas engines and other lines, soon open to change. Strong on jig design. Age 40; best references, all particulars. Box 841, AMERICAN MACHINIST.

Manager, experienced in manufacture and sale of gasolene engines and other machinery, and operation of gray-iron foundry seeks opening. Investment if desired after making good. References as to habits, character, ability. Young man, hustler, competent. Box 842, AMERICAN MACHINIST.

MISSOURI

Position wanted by mechanical engineer with ten years' mechanical and electrical experience. Present position—chief draftsman. A good executive, hustler, systematizer and correspondent with uptodate methods; age 30; salary expected, $1800; will locate anywhere. Box 900, AMERICAN MACHINIST.

NEW JERSEY

An inventive, thorough, broadly experienced mechanic, practical toolmaker; an organizer, proven ability, wants change; responsible position. Reliable firms only. Box 622, AMERICAN MACHINIST.

Mechanical draftsman wants position, with growing concern preferred; experienced, first-class man in construction of small tools, special machinery, sub-die presses, etc. Address Box 899, AMERICAN MACHINIST.

NEW YORK

Wanted—Position as draftsman, detailer or tracer. Can give best of references. Box 893, AMERICAN MACHINIST.

Young mechanical draftsman, 6 years' varied board experience, wishes position with a manufacturing concern. Box 896, AM. M.

Mechanical engineer, six years' experience in general engineering work, desires position near New York City. Salary moderate. Box 874, AMERICAN MACHINIST.

General foreman, 22 years' practical experience; expert on steam engine and general work; thoroughly versed in best shop practice; can handle men to advantage and produce results. Box 852, AMER. MACHINIST.

Mechanical engineer, expert in development of automatic machinery and tools, 16 years' factory experience, technical graduate, thorough and finished draftsman, practical constructor, now employed, desires engagement with progressive concern. Box 895. AM. M.

Expert mechanic now in charge of the manufacturing departments of large plant desires connection with manufacturer to develop improved and patentable features along the line of mechanical specialties. Well versed in the construction of patent specifications. Contract on royalty basis. Address "Q. E. X.," AMERICAN MACHINIST.

OHIO

Engineer of established reputation, wide experience apprentice to works manager, intimate knowledge of best shop and machine tool practice on heavy work, gilt-edged record, is open for engagement as works manager with full responsibility and can deliver the goods. Box 865, AMERICAN MACHINIST.

OREGON

Master mechanic, responsible, wide-awake man, with extensive and varied experience in construction and manufacturing in the States, Canada, South America and Germany; age 40. Box 720, Saint Johns, Oregon.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreign sales manager, desires position as latter at London, with A-1 American engineering firm. Thoroughly familiar with English and Continental business; up-to-date hustler. Box A.2, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—A couple of experienced tool and die makers. Apply, stating experience, etc., to Box 888, AMERICAN MACHINIST.

Wanted—Director for the Hamilton Technical Institute, one having sufficient experience in technical education to organize and conduct a first-class, new, up-to-date institution. Duties to commence at Easter. Applications received up to March 15th. Apply, stating experience, qualification and salary expected, to R. H. Foster, Esq., Sec'y Bd. of Education, Hamilton, Canada.

CONNECTICUT

Wanted—A live man in every large machine trade center to handle on commission a new and quick selling small tool. Must have trade acquaintances and furnish local references. Box 869, AMERICAN MACHINIST.

ILLINOIS

Wanted—General foreman for the power apparatus shops. Applicant must have good mechanical and executive ability; one with experience in the manufacture of generators and motors preferred, though this is not a necessity. Apply by mail only, stating age, experience in full detail and salary expected. Personal interview may be arranged for later. Address Department No. 29, Western Electric Company, Chicago.

MASSACHUSETTS

Wanted—Experienced mechanical draftsman for special machines and tools; must be quick to grasp ideas and capable of correct and rapid drawings. Box 883, AMER. MACH.

MICHIGAN

Wanted—Experienced operator on Potter & Johnson turret machines, who is competent to take charge of several machines, turning out good work advantageously. State experience handling men, wages, age, nationality. We want a man who can turn out a maximum amount of good work. Box 838, AM. M.

NEW JERSEY

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

NEW YORK

Wanted—Working foreman for small jobbing shop. The right man will be given a small interest in the business. Box 898, AMERICAN MACHINIST.

Wanted—First-class toolmakers, experienced on all-round tool and die work, who can produce work quickly and accurately. No others need apply. Box 885, AMERICAN MACHINIST.

OHIO

Toolmaker; one competent to make tools for rolling and drawing sheet metal. Address The Lunkenheimer Co., Cincinnati, Ohio.

Wanted—Competent sales manager by a machine tool manufacturer. Liberal salary to a very high class man. Box 833, AMER. MA.

Superintendent Wanted—With experience as machinist, draftsman and foreman. Must be capable of handling men in manufacture of machinery. Moderate salary at start, with stock bonus if satisfactory. Box 889, AM. MA.

Wanted—Superintendent metal working plant. Must have thorough knowledge shop system, mechanical training and ability to handle men. Answer fully, giving experience and salary. Address C. A. Nibot, 117 Woodbine Avenue, Youngstown, Ohio.

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Wanted—A case hardener. Must be thoroughly familiar with cyanide and pack hardening of steel punchings, machinery steel pinions, hubs, gears, etc. Preferably a man who has had several years' experience on gun work desired. Box 872, AMERICAN MACHINIST.

Wanted—A man with general machine shop experience and clerical ability to figure prices for estimates and piece rates. Give experience, age and references. Box 887, AMER. MA.

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(SCHMIDT PATENT)

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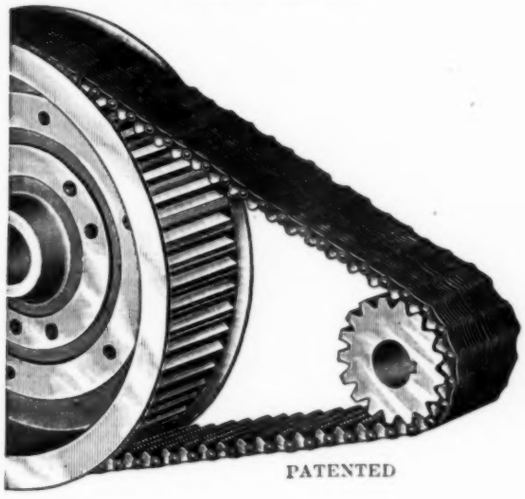
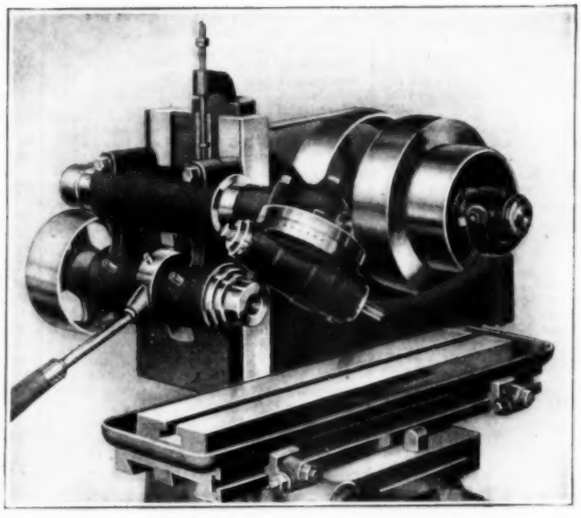
Detachable and Riveted Roller Chains.

All popular sizes.





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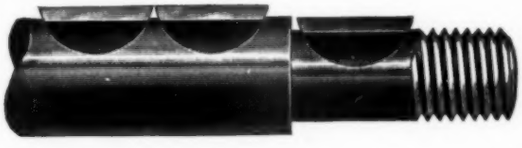

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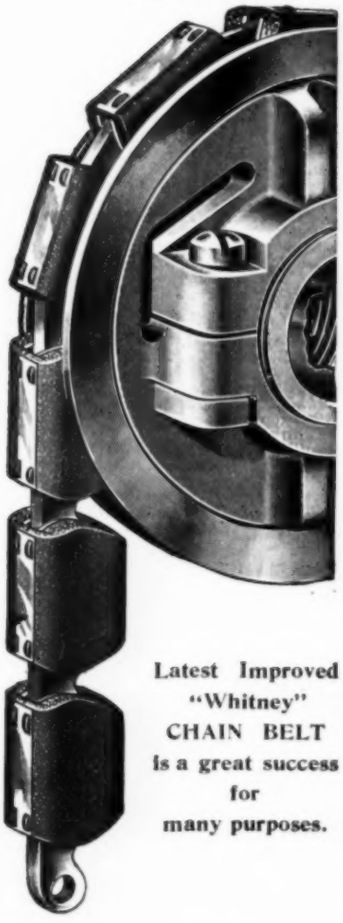

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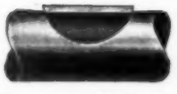

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An Analysis of 5500 Machine-shop Accidents

Most of Them Are Due to Natural Hazards of the Occupation, Others to Personal Carelessness—Only a Few Preventable by Safety Devices

BY L. P. ALFORD

During the last few months there has been considerable discussion of accidents and their prevention, in both the technical and daily press. At the present time there are two societies that are actively urging upon the public a consideration of the enormous wastes of life and property from accidents and suggesting, in more or less detail, means for their prevention. Some State legislatures have enacted statutes tending to minimize the hazard of certain industrial occupations and to provide safeguards in the nature of safety appliances. Yet thus far but little has been done in this country, compared with the leading industrial nations of Europe.

Whatever legislation is enacted or whatever agitation for such legislation is carried on, such actions should be based on a clear knowledge of the causes of accidents, what classes of accidents can be prevented by safety appliances and what classes are unpreventable, by rational means, from the natural hazard of the occupation. It is, therefore, opportune to present an analysis of machine-shop accidents with the purpose of showing their nature, by what agents they are produced, their causes as far as can be ascertained, and to suggest, if possible, rational safety devices that can be used to minimize the number of such accidents.

An opportunity was presented and embraced to analyze the hospital records of a large machine-building firm in Massachusetts. This firm builds light- and medium-weight automatic and semi-automatic machinery; in addition to the regular machine-shop departments it operates its own iron foundry and drop-forging shop. Its plant is new and strictly modern in design and construction, which means that there is ample provision for both natural and artificial light, and for ventilation.—Excellent light unquestionably minimizes the number of machine-shop accidents.—Its machine-tool equipment is very largely new; that is, purchased within the last five to seven years, and represents the best products of the foremost machine-tool builders of the United States.

The structural and equipment conditions are much better than the average of machine-shop conditions as they exist today throughout this country. Furthermore, the State of Massachusetts has done as much as, if not more than, any other State in the Union in passing laws regulating factory conditions. These laws cannot be looked upon from any other viewpoint than one of approval. Thus the existing machine-shop conditions are among the best that can be found in this country today, both because of the buildings, the attitude of the management and the carrying out of beneficent State laws. These conditions must have a tendency to reduce the number of accidents per unit number of employees, and may produce a ratio of the number of accidents per year to the number of employees that is somewhat less than a similar ratio from all of the machine shops of this country, provided the latter figure could be obtained.

Practically all of the employees of the machine shop itself are men; that is, there is very little female help in the machine shop proper.

Among the uptodate features of the factory equipment is a well furnished shop hospital. This is centrally located in a room especially designed for the purpose, is provided with an outfit of hospital furniture and instruments for treating accidents and performing minor operations, such as finger amputations; it is in charge of a registered, male hospital nurse. To this hospital room all subjects of accidents throughout the entire plant are sent for first-aid treatment. A record is kept of every case that is thus treated. These records now extend back over a period of about four years, and number many thousand cases. For the purpose of this analysis, the records for the years 1906 and 1907 were selected, as it was recognized that business conditions throughout the year 1908 rendered the records for that year somewhat abnormal.

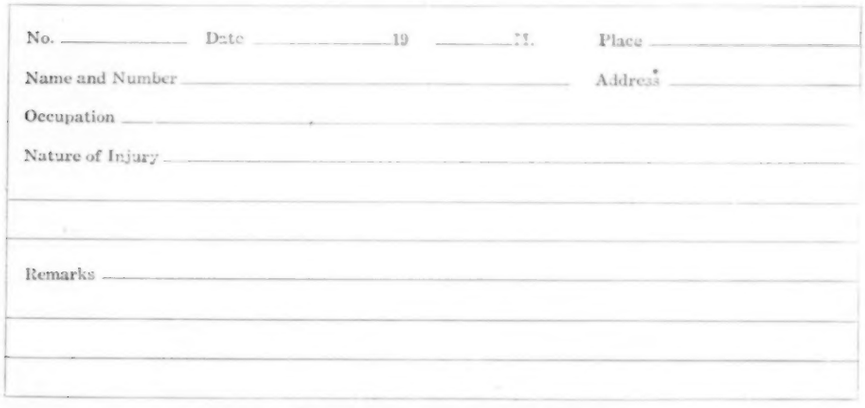

FIG. 1. EMERGENCY HOSPITAL RECORD FORM

The Hospital Records

These records are kept in large bound volumes, each page of which has blanks sufficient for four individual accident reports. The form into which each report is filled is shown by the line engraving, Fig. 1. This calls for the accident number; the date (and whether forenoon or afternoon); place (section of the factory); the name and shop number of the patient and his home address; his occupation (that is, lathe hand, milling-machine hand, planer hand, helper, or the like); the nature of the injury in detail, and under the heading "Remarks," a statement from the patient expressed in his own words as to how the injury was received, together with a statement by the hospital attendant as to just what treatment was given.

Items.	Number.	Classification.
1	174	Serious.
2	5208	Minor.
3	46	To clerical employees.
4	149	To outside employees.
	Total, 5577	

TABLE 1. GENERAL CLASSIFICATION OF MACHINE-SHOP ACCIDENTS.

A practicing physician of the city where the plant is located has general supervision of all this hospital work, although the actual hospital attendant is the registered nurse to whom I have referred. In cases of serious or major accidents this doctor, or one of his associates, is always called. This applies to deep or extensive wounds requiring stitches to close them, to amputations, and the like. The attendance of this doctor, or one of his associates, on a case always forms a part of the hospital record. In addition to the record as outlined all serious accidents are reported to the employers' liability insurance company with which the firm is insured. The sending in of such a report to the insurance company is noted on the record.

This insurance-report record was made the determining feature as to whether or not an accident should be considered as minor or serious for the purpose of this analysis; that is, all accidents that were reported to the employers' liability insurance company were considered as serious accidents and were analyzed in detail as to their nature and cause, so far as possible. All other accidents were classed as minor; as very few, if any, of them prevented the patient from returning to his work immediately.

Total Number of Accidents

The total number of accidents recorded for the years 1906 and 1907 is 5577; deducting the accidents to outside employees we have the number 5428, or 2714 per year. The average number of employees for the year 1906 is 2585; similarly, for the year 1907, 2592. Thus, at the outset we have a rough factor of one accident per employee per year. In considering this fact it must not be lost sight of, however, that many of the accidents are minor, consisting of cut fingers, particles of steel or emery in the eyes and like injuries.

Items.	Number.	Nature of Accidents.
1	3799	Injuries to fingers, hands, wrists and forearms; such as contusions, lacerations, punctures, incisions and the like.
2	1074	Foreign bodies in the eyes.
3	75	Lacerations and contusions of the face.
4	62	Contusions of feet and ankles.
5	41	Lacerations and contusions of the head.
6	39	Burns.
7	25	Punctures in the feet caused by nails.
8	21	Injuries to the legs.
9	9	Septic conditions.
10	9	Boils.
11	5	Heat exhaustion.
12	4	Indigestion.
13	4	Persistent nose bleeding.
14	3	Injuries to shoulders.
15	3	Fainting.
16	2	Chills
17	1	Rheumatism.
18	1	Tonsilitis.
19	1	Pleurisy pains.
20	15	Miscellaneous.
21	15	Accidents received outside of the premises of the factory.
	Total, 5208	

TABLE 2. GENERAL CLASSIFICATION OF MINOR ACCIDENTS.

Table 1 shows a general classification of the total number of accidents into four sections. These are: Serious, that is, accidents which were reported to the insurance company; minor, that is, such as occasioned no loss of time on the part of the patient; clerical, that is, to the office force, including clerks and executives; and lastly, to outside employees. This latter classification takes care of accidents that occurred to the employees of contractors who were carrying on building operations and construction work throughout the plant. This work can be justly considered as more hazardous than ordinary machine-shop work, and it was, therefore, classified by itself, and no use is made of this classification in drawing the deductions that are presented near the end of this article. In passing it is worthy of notice that no fatal accidents occurred to any of the machine-shop employees during the period that we are considering. On the other hand, three of the accidents that are classed under item 4 of Table 1 terminated fatally. These were one death from electric current, one death from gasolene burns, one death from crushing by a contractor's sand car. The two items of Table 1 that we are to consider are the serious accidents, numbering 174, and the minor accidents numbering 5208.

Items.	Number.	Agent of the Burns.
1	12	Hot metal in the foundry.
2	6	Hot chips from cutting tools.
3	5	Hot steel in the forging shop.
4	3	Flames from a furnace.
5	2	Flames from a gasolene torch.
6	2	Hot steam pipes.
7	2	Hot oil and flame when thawing a barrel of oil with a heated bar.
8	2	Whitewash.
9	1	Hot poker in the fire-room.
10	1	Hot water from a steam-driven pump.
11	1	Arc from an electrical switch.
12	1	Flying melted babbitt—moisture.
13	1	Sunburns.
	Total, 39	

TABLE 3. DETAILED TABULATION OF AGENTS PRODUCING MINOR BURNS.

The Minor Accidents

These minor accidents are subdivided into 21 sections in Table 2. By far the larger part are lacerations, contusions, incisions and other injuries to fingers, hands, wrists and forearms. The total number of these accidents is 3799. The second largest item is of foreign bodies in the eyes, such as emery grit, dust, bits of steel, and the like. The number of such cases is 1074. The injuries to feet and ankles number 108; to face and head, 116. The number of burns of various kinds is 39; these are classified in more detail in Table 3. A consideration of these two tables, Tables 2 and 3, bears out my statement in the title that most of the machine-shop accidents are due to the natural hazard of the occupation. The latter part of Table 2 will be seen to contain a few cases medical in character, in which temporary relief was administered in order that the patient might keep at work.

Items.	Number.	Nature of the Accidents.
1	99	Lacerations and contusions of fingers, hands, wrists and forearms.
2	28	Lacerations and contusions of feet and legs.
3	16	Lacerations and contusions of face and head.
4	11	Miscellaneous.
5	13	Received in drop-forging shop.
6	7	Received in iron foundry.
	Total, 174	

TABLE 4. GENERAL CLASSIFICATION OF SERIOUS ACCIDENTS.

The Serious Accidents

The total number of serious accidents, as shown in Table 1, is 174. These are divided into six sections in Table 4. This total figure is small when compared with the number of employees. The average is about 3½ accidents per 100 employees per year. The largest item is that of lacerations, contusions, etc., of fingers, hands, wrists and forearms. In this respect Table 4 is similar to Table 2, which details the minor accidents into broad classes. The next important item is of injuries to the feet and legs; then follows injuries to the face and head. For the purpose of closer analysis items 5 and 6 of this table refer to the drop-forging shop and foundry, respectively. They were classified in this way in order to separate them from the machine shop proper.

Items.	Number.	Agent or Nature of the Accidents.
1	14	Contusions caused by falling objects, principally castings.
2	13	Lacerations and contusions caused by milling-machine cutters; two amputations resulted.
3	7	Lacerations and contusions caused by milling-machine cutters. In each case the sleeve of the patient's clothing was caught by the rotating cutter.
4	12	Contusions and lacerations received from lathes. In four cases the fingers or hands were caught in the gears.
5	11	Injuries from punch presses. Three amputations resulted.
6	8	Injuries from emery wheels.
7	8	Cuts and incisions from hand tools, such as knives, chisels, gouges and the like.
8	3	Punctures from files.
9	2	Contusions from contact with gears of upright drills.
10	2	Crushed in a shaper.
11	2	Crushed in a metal planer.
12	2	Burned and lacerated between a belt and pulley.
13	2	Injuries received from a buzz planer.
14	2	Injuries from revolving stock in a screw machine.
15	2	Crushed between jig and part of a machine.
16	2	Lacerations caused by nails projecting from a tote box.
17	1	Injuries from a circular saw; amputation resulted.
18	1	Crushed in feed mechanism of a machine.
19	1	Contusion caused by shipper of machine.
20	1	Lacerations and incisions caused by band-saw.
21	1	Crushed by the falling head of an upright drill; the counterweight chain broke.
22	1	Laceration from loose pulley in trying to stop it.
23	1	Laceration from automatic screw-machine tools, saw and drill.
	Total, 99	

TABLE 5. DETAILED TABULATION OF SERIOUS ACCIDENTS TO FINGERS, HANDS, WRISTS AND FOREARMS.

Table 5 is a detailed analysis of item 1 of Table 4. Similarly, Table 6 analyzes item 2 of Table 4; Table 7 analyzes item 3; Table 8 analyzes item 4; Table 9 analyzes item 5; and Table 10 analyzes item 6. All of the items thus referred to are the items as they show in Table 4. It is unnecessary to call particular atten-

tion to each one of the items in Tables 5 to 10, inclusive, but specific reference will be made to certain of them in the section of this article devoted to the conclusions. It is urged, however, that the reader carefully consider the agent and nature of the accidents as they are detailed in these tables, for they show what machine-shop accidents are. With a very few exceptions the information given is specific as to the nature and agent of the accident, although there are a few cases where the original information was not in detail and, therefore, the data as tabulated are not specific.

Conclusions

It is extremely difficult to draw general conclusions from data such as are presented by these tables, for the line between carelessness and the natural hazard of the occupation is by no means clearly defined. Again, it is easy to take different positions in regard to what are and what are not preventable accidents. Yet a few general conclusions seem justified.

A thoroughly equipped emergency room, or its equivalent, with a proper attendant, is to be recommended for all machine shops employing a large number of men. The factors shown in the preceding paragraph indicate one accident for every employee each year. Of these accidents 3½ will be of a serious nature for each 100 men employed. In addition to the humanitarian features of such a hospital room, there is a decided advantage to production in avoiding a loss of time on the part of the patients who receive minor injuries.

Items.	Number.	Agent or Nature of the Accidents.
1	13	Contusions from falling objects, principally castings.
2	5	Contusions from trucks or from objects falling from trucks.
3	2	Contusions from castings dropped by fellow employees.
4	3	Injuries received from elevators.
5	1	Contusions resulting from being caught between jig and machine.
6	1	Lacerations from an emery wheel.
7	1	Incised wound from a knife.
8	1	Incised wounds from a piece of sheet steel.
9	1	Scald from hot water. Patient tipped over a bucket.
	Total, 28	

TABLE 6. DETAILED TABULATION OF SERIOUS ACCIDENTS TO FEET AND LEGS.

The machinist who keeps a small bottle of cocaine and a few toothpicks to remove objects from his fellow employees' eyes, and a small roll of bandages and a little collodion to wrap up cut fingers, may be looked upon with approval from a humanitarian standpoint; yet it needs no argument to prove that it is far better that these minor accidents be treated according to modern medical practice and surrounded with all necessary safeguards against infection. One of the stringent rules in the factory from which my data are taken is that no first aid in case of accidents shall be given by anyone throughout the plant except the duly authorized attendant of the emergency hospital. The number of the machine-shop accidents per 100 employees, as indicated by the factors that I present, should have a direct influence in bringing about a considera-

Items.	Number.	Agent or Nature of the Accidents.
1	4	Lacerations and contusions from falling objects.
2	3	Contusions and lacerations from emery wheels. In each case the wheel burst.
3	5	Lacerations and contusions from falling against objects.
4	3	Lacerations and contusions from flying or slipping tools.
5	1	Burns from flying babbitt.
	Total, 16	

TABLE 7. DETAILED TABULATION OF SERIOUS ACCIDENTS TO FACE AND HEAD.

tion of hospital facilities in all large machine shops.

Some of the most horrible accidents occurring in machine-shop life are from belts and pulleys, particularly in connection with the transmission of power. That such an equipment can be installed, operated and maintained without such accidents is shown by the analysis here presented. Not a single accident is recorded as having occurred from any falling piece or member of any of the overhead power-transmission machinery, nor is there any other record of injury from any of the mechanical power-transmission apparatus. It is well to point out in passing that the laws of the State of Massachusetts and the requirements of the State police inspectors are rigid in regard to this class of factory equipment.

A consideration of the minor accidents, and of the number of minor accidents compared with the total number of accidents, leads to the conclusion that the majority of machine-shop accidents are due to the natural hazard of the occupation. This conclusion is established by the number of minor accidents to the fingers alone; this is 3799 out of a total number of accidents to the machine-shop employees of 5428.

A further conclusion is that but few of the total number of machine-shop accidents are preventable by rational safety appliances. This must not be construed as an argument against safety appliances, for some such devices can be used and should be used; but the good which can be done from the adoption of such devices is undoubtedly far less than a superficial consideration of the subject would lead one to believe.

An expert in the operation of a machine or tool can undoubtedly perform certain operations with safety, which would be extremely hazardous to a less adept workman. Thus carelessness may, and often does, follow directly as a result of increased expertness, or to use a homely phrase "familiarity breeds contempt." This leads to the conclusion that one of the important duties of foremen should be to watch for careless moves on the part of their workmen, and particularly on the part of the younger men and boys. In the old days of apprenticeship, when the boy learned not only his craft but also his general fund of knowledge from his master, instruction was undoubtedly carefully given in regard to the careless handling and use of machines and tools. With the decadence of the apprenticeship system, it is doubtful if the youngster of today is as carefully instructed, in details of his work that add to his own personal safety, as was the apprentice boy of years ago.

Certain safety devices could be, and undoubtedly should be, added to some of our standard machine tools by the maker, to the end that certain accidents which are now common would be eliminated, or at least greatly reduced in number; if they did then occur, responsibility therefor would be upon the individual workman and not upon the designer and builder of the machine, or the purchaser thereof.

Carelessness of Workmen

Two of the points brought out in the preceding sections may be expanded with profit. One is the features concerning which workmen are more or less careless, and concerning which the younger employees at least should be properly instructed by their foremen.

Items.	Number.	Agent or Nature of the Accidents.
1	1	Injury to shoulder. Fell from wooden horse.
2	1	Injury to hip. Fell from wooden horse.
3	1	Dislocated knee.
4	1	Burn from hot cotton seed oil; thawing a barrel.
5	1	Contusion of the abdomen. A board was thrown from a revolving circular saw.
6	1	Rupture, caused by board thrown from circular saw.
7	1	Laceration from nail in tote box.
8	1	Strain of the back from lifting.
9	1	Lacerations and contusions caused by fall over pile of shafting.
10	1	Paralysis.
11	1	Lumbago.
	Total, 11	

TABLE 8. DETAILED TABULATION OF MISCELLANEOUS SERIOUS ACCIDENTS.

With reference to clothing: All clothing should be tightly fitting and so worn that there are no loose portions which may be caught in gears, cutters, belts, pulleys, or other revolving or moving parts of machines. Loose sleeves are especially to be avoided, as is witnessed to by item 3 of Table 5. I have personally seen several horrible accidents, in which the tendons of the wrist were severed by milling cutters or milling saws, the pri-

mary cause of the accident being the catching of the operator's sleeve in the rotating cutter. In every case these accidents were to young men or boys in their teens, and in several cases the injury was of such a serious nature that the hand was crippled for life. Such a crippling is a terrible handicap for a young man who must earn his own living under the conditions of industrial competition that prevail today. Therefore, a caution to wear tight-fitting sleeves or better still, to roll the sleeves of all garments above the elbow is wise in connection with general machine-shop work.

Similarly, there is danger in the loose flying lower part of a jumper, or in the slack of a jumper in the back. Such portions are very apt to be caught in gears and belts, or wound up in revolving stock, as in screw machines and turret machines. This point is brought out by item 14 of Table 5.

The wiping around rotating cutters and gears, and moving parts of machines is to be avoided; it is a very easy matter for a piece of waste to be caught by some moving part of a machine and thereby draw the hand into the mechanism. The injuries that result from getting caught in gears, belts and moving parts of machines, are shown by items 4, 9, 10, 11, 12, 18, 19 and 22 of Table 5.

Another point to be avoided is using a file without a handle, or a file that has a loose handle. Such a tool may easily produce serious punctures. (Refer to item 8 of Table 5.)

The need of piling castings and laying down heavy objects so that they cannot fall from any cause whatever is shown by the accidents tabulated under items 1 of Table 5; 1, 2 and 3 of Table 6, and 1 of Table 7. Accidents of the nature indicated by these items are more apt to occur to a person from the acts of others than from acts of his own.

Throwing a piece of board containing nails upon the floor so that the points of the nails project upward is to be condemned as gross carelessness. A very little thoughtfulness is sufficient to throw the board so that the nails point downward, or if there are nails projecting from both sides of the boards, to bend them over on one side and then throw it so that the nails projecting from the other side will come in contact with the floor. That nails are a prolific source of injury is shown by item 7 of Table 2.

The need of especial care around dangerous tools, such as punch presses, buzz planers and circular saws, is shown by the accidents recorded under items 5, 13 and 17 of Table 5, also items 5 and 6 of Table 8. These items record four amputations, one of which—item 17—was the entire amputation of a hand.

That care should be used in handling sharp tools is indicated by item 7 of Table 5, and item 7 of Table 6.

Many of these points to be guarded against may seem commonplace in the extreme, and as written are merely statements of facts which are known and recognized by machine-shop workmen, yet the fact of the large number of accidents resulting from failure to guard against these points is a sufficient reason for restating them as has been done.

Safety Appliances

The preceding section has been written to point out a few places where care should be exercised by the individual workman in order to guard himself from accidents that are incident to the trade. This section will point out for consideration a few places where rational safety devices might be adopted to prevent certain other classes of machine-shop accidents.

Items.	Number.	Agent or Nature of the Accidents.
1	2	Fracture of toe caused by falling object.
2	1	Amputation of fingers in hammer dies.
3	1	Fracture of fingers in hammer die.
4	1	Amputation of fingers in trimming press.
5	4	Lacerations of fingers from flying pieces of steel.
6	1	Laceration and contusion of face by a flying blacksmith's set.
7	1	Incisions in the leg from a flying piece of steel.
8	1	Puncture in the abdomen from a flying piece of steel.
9	1	Burns near the eyes from flying pieces of scale.
	Total, 13	

TABLE 9. DETAILED TABULATION OF SERIOUS ACCIDENTS OCCURING IN THE DROP-FORGING SHOP.

Items.	Number.	Agent or Nature of the Accidents.
1	1	Serious vitriol burns from pickling castings.
2	1	Contusions of the feet from a falling casting when crane sling broke.
3	1	Cut in the throat from a flying splinter of wood when chopping wood.
4	1	Laceration of the hand from the breaking of a casting gate.
5	1	Lacerated fingers. Caught in hoist chain.
6	1	Contusion of the chest, caused by flying plank.
7	1	Gas poisoning from breathing air in a core oven.
	Total, 7	

TABLE 10. DETAILED TABULATION OF SERIOUS ACCIDENTS OCCURRING IN THE FOUNDRY.

It should be unnecessary to touch upon the point of guarding gears, but accidents from gears are common, as shown by items 4 and 9 of Table 5.

The number of accidents from contact with milling-machine cutters is so large as to warrant a consideration of suitable guards for milling cutters to prevent the hands or arms of the operator from the serious injury that frequently results. (See items 2 and 3 of Table 5.) These items record 20 injuries, or 12 per cent. of all the serious machine-shop accidents tabulated. In several countries of Europe, guards are required by law for milling-machine cutters.

The subject of guards and safety devices in connection with the operation of punch presses, circular saws and buzz planers, which are recognized as some of our most dangerous machines, has been frequently discussed; yet little has been done in this country to develop and use such guards in a rational manner. The serious accidents that result from operating these tools are shown by items 5, 13 and 17 of Table 5, and items 5 and 6 of Table 8.

That there is a necessity for guards for emery wheels and polishing wheels, and for care that such wheels are not run at an excessive speed, is shown from the accidents resulting from emery wheels, item 2 of Table 7. The fact, of course, should be recognized that an emery wheel may be broken, or caused to burst from improper use, as excessive pressure or blows when grinding a tool, as well as from excessive speed.

Suitable guards are necessary for revolving screw-machine stock, as is indicated by item 14 of Table 5. Proper supervision of laboring help in trucking castings, boxes and other parts around the factory, and storage devices for such parts are necessary, as indicated by the large number of accidents from falling objects, principally castings. (See Item 1 of Table 5, and 1, 2, and 3 of Table 6.)

The familiar tote box in the average machine shop is made of wood and is usually in a more or less advanced condition of decrepitude. Accidents from nails in tote boxes (see Item 16 of Table 5, and 7 of Table 8), while not large in number, are sufficient to be considered an argument in favor of the modern metal, shop tote box, so designed as to be free from sharp corners, or other portions which may cut or injure the hands of the person who is handling it.

The items that have been mentioned in the two immediately preceding sections of this article refer, with only a few exceptions, to the serious accidents that were analyzed as to their agent, nature and cause. It is fair to assume that the minor accidents which were not investigated in detail would bear a general proportion as to their cause, to the causes of the serious accidents as indicated in Tables 5 to 10, inclusive. Therefore, agencies which reduce the number of serious accidents, will tend to reduce the number of minor accidents in a similar proportion.

Engineering and technical education in China is receiving considerable attention in a progressive manner, and in following a policy adopted a few years ago, twenty Chinese students were recently sent abroad by the provincial government of Chekiang to continue their studies. A few went to Belgium, one to Germany, and the remainder came to the United States. All are pursuing engineering subjects.

The Vulcan Shipbuilding Works of Stettin

An Important German Plant Where Many Warships and Transatlantic Liners Have Been Built—Views of the Machine Shop

BY J. B. VAN BRUSSEL

One of the important engineering and shipbuilding works of Germany is the Vulcan plant, situated on the estuary of the river Oder in a suburb of the city of Stettin. At this plant many of the warships of the German navy, and a large number of German Transatlantic liners have been constructed. The plant covers an area of some 1,700,000 square feet, and its stone and steel buildings have a floor area of some 275,000 square feet. There are several large slipways available for the largest vessels, and all of the necessary workshops for fabricating the material for the hulls and building the engines and machinery.

The four accompanying half-tone illustrations, Figs. 1 to 4 inclusive, show views in the machine shops. The greater number of machine tools in all of these shops are electrically driven. Current for both power and lighting is generated in a central station, whose capacity is some 4000 horsepower. The machine shops proper are 492 feet in length, 262 feet in width and 65 feet in hight, while the erecting shop is 394 feet long, 88 feet 6 inches wide and 98 feet 6 inches high. This is capable of handling nine large marine engines in the process of erection at a single time.

A special building is provided for the manufacture of locomotives. This shop employs 600 workmen and turns out about 100 locomotives per year. Fig. 1 shows a part of this locomotive shop. Several milling operations can be seen near the lower right-hand corner of this view, and lathe operations at the left. It will be noticed that the lighting for this shop is by means of electric arcs.

Figs. 2, 3 and 4 show sections of the machine shop used in connection with the shipbuilding. Of these Fig. 4 is a view of the main bay of this shop. Turning to Fig. 2 a milling machine of unusual design can be seen near the lower right-hand corner. This machine is provided with two knees, a long table and a rigid type of overhanging arm. It is at work upon the forging for a connecting rod. A noteworthy feature of all of these views is the extreme cleanliness of the shop

FIG. 1. LOCOMOTIVE SHOP OF THE VULCAN WORKS, STETTIN, GERMANY

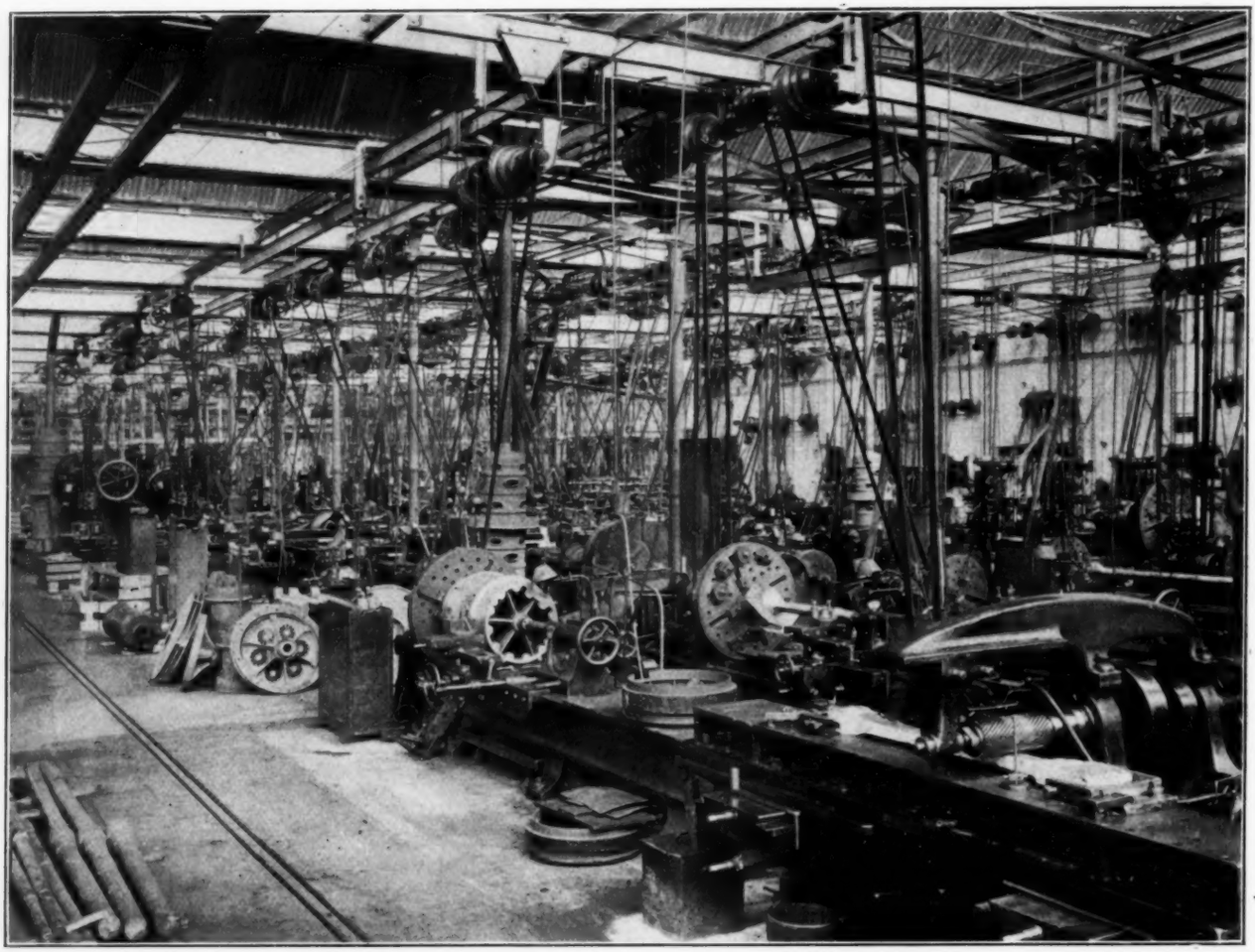

FIG. 2. SHIPBUILDING MACHINE SHOP OF THE VULCAN WORKS

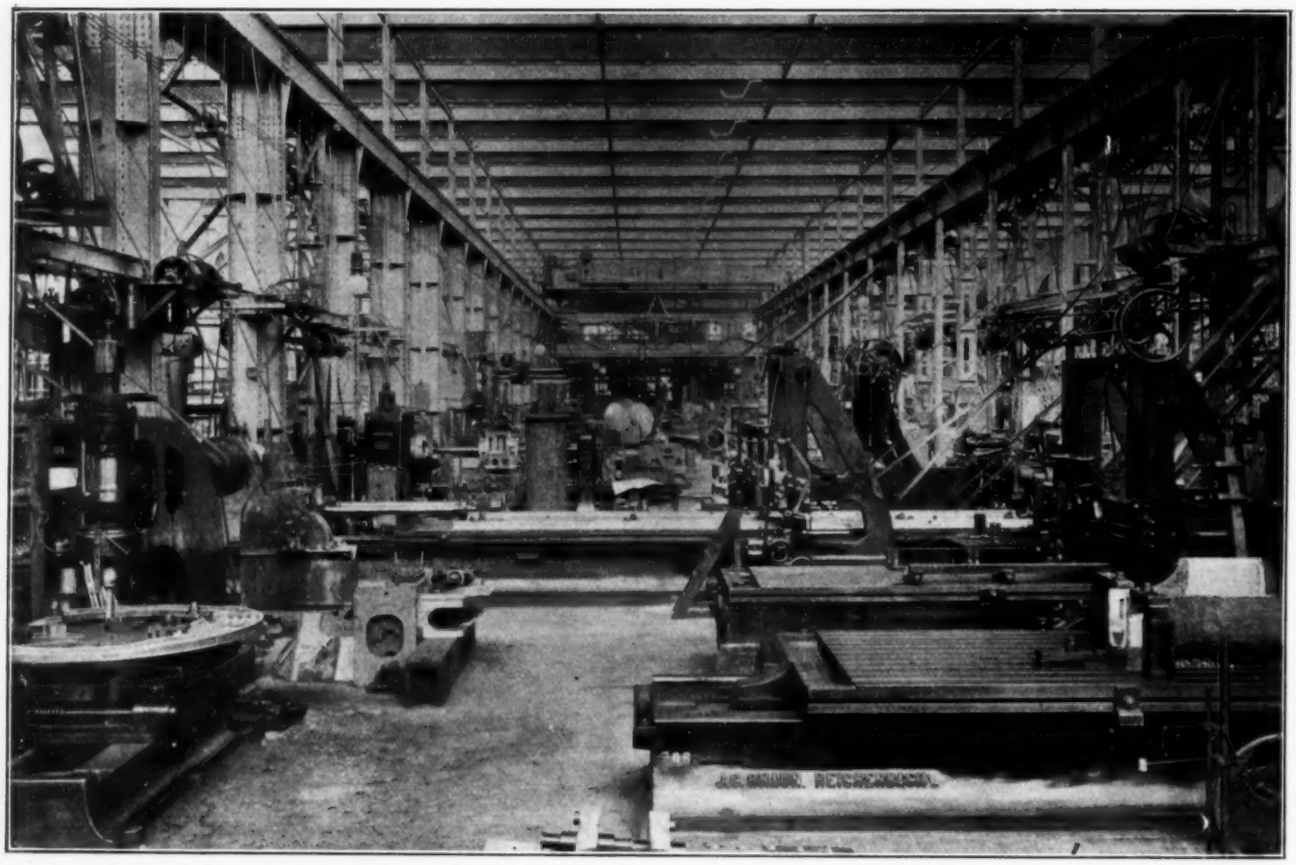

FIG. 3. ANOTHER VIEW IN THE SHIPBUILDING MACHINE SHOP

floors and machines, indicating the best of shop conditions.

Fig. 3 shows in the foreground several large planers, and at the left a large vertical miller. This bay, as well as the main bay (shown in Fig. 4) is served by overhead cranes.

Some five miles of standard gage railway connect all of the departments of the plant with each other and with the State railways. The material which is received by rail is sent at once to the department or the machine where it is

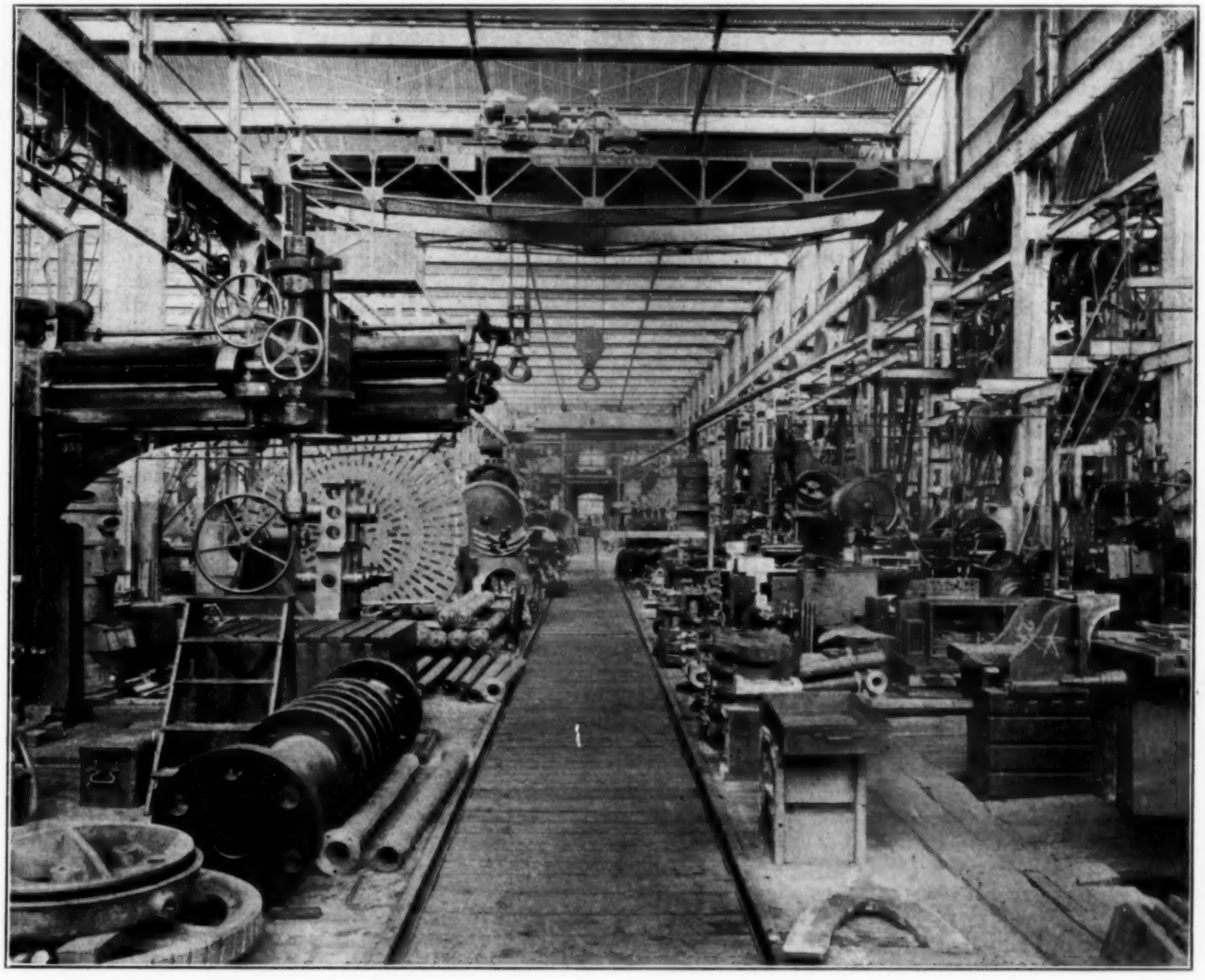

FIG. 4. MAIN BAY OF THE SHIPBUILDING MACHINE SHOP OF THE VULCAN WORKS

to be handled and there unloaded. In connection with water transportation, two ferry steamers are constantly in service, each one of which can handle three freight cars at a time.

In reading the accounts of the immense forest fires that were raging during recent months in different parts of the country few realized the enormous extent of the loss thus sustained which is estimated by an official in the Department of Agriculture to have been at the rate of $1,000,000 a day, which estimate is not considered to be excessive.

Where, in Relation to the Critical Points, Should Steel be Heated for the Best Results when Hardening?

By W. Osborne

Scientific researches have changed many of our ideas concerning steel, and while we have a lot of new ideas on the subject there are many missing links in places.

If I understand the matter rightly there is a point, when a piece of carbon tool steel is being heated, where the carbon changes its form or its combination with the iron. When this change takes place heat is absorbed without a rise in temperature. Before this change takes place the steel will not harden, or as the shop men say, "It will not take a temper." After a piece of steel has been heated above the temperature necessary to harden it and then allowed to cool it will radiate heat and get cooler for a time. At a temperature near where the heat was absorbed, in the heating, without a corresponding rise in temperature the piece of steel will continue to give out heat without any fall in temperature. Often, when the conditions are right for observation, it may even seem to get hotter.

It seems likely that this change was first recognized on a falling heat for it has been called the recalescent point, that is to say, the reheating point. With iron there are three of these points both going up and coming down, really six points in all for while the things that take place going up are reversed or undone coming down yet there is a difference in temperature at which they take place. While in irons these points are quite a ways apart in the matter of the temperature at which they take place, in tool steels they are very close together, so close indeed that in practice they may be considered as being one. Among other names these points have been called the critical points and this seems to be a very good name for them for everyday use.

Recognizing the critical point in a piece of tool steel as the dividing line between where it will harden and where it will not, an extremely important practical

question arises. Where above the critical point is the best point for quenching to get the best results? Generally the expert's directions are to harden steel at the lowest heat that will give the necessary hardness. From this it might be inferred that steel got harder and harder the hotter it is heated. Is, or is not, this the case?

It can readily be supposed that if there is a change in the carbon at the critical point, whereby it acquires the power of hardening, this change is going on all the time that the steel is passing through the critical point, then, if the steel was dipped soon after the change had begun very little of the carbon would have changed and the steel would have very little hardness. Following this idea out it would appear as though the steel would get harder if dipped when the change had progressed farther. After the change is complete in the piece and all of the carbon has assumed the form of hardening carbon, is there an added advantage in raising the heat still farther? And if there is, how much higher should it be raised?

This change at the critical point has by some writers been explained by calling attention to the action of ice in being changed into water. If it is really like that a good reason for further heating does not appear, at least on the surface. On the other hand it might be that steel is more like salt and water frozen together. The heat melts the water and the water dissolves some of the salt, and the hotter the water is heated the more salt it will dissolve. Ice frozen slowly is said to be nearly free from salt but if it could be frozen as quickly as a piece of steel is quenched the salt might not have time to get out of solution. In such a case it would follow that the higher the heat it was frozen from the more salt there would be in the frozen mixture. It would also follow that the quicker it could be frozen from any given temperature the less chance the salt would have to get out of solution.

This likening a piece of steel to a chunk of ice or to a mixture of salt and water may be all wrong but the whole range of ideas about the critical point and the theories lately advanced to explain hardening are so new that something has to be used to hang our thoughts on while we are trying to explain them, and trying to get further information as to the facts in the case.

While the ordinary steel worker has never had any sure way of testing a piece of steel that is thoroughly hardened yet it seems certain that the quicker the heat is got out of a piece of steel the harder it becomes. While there is no standard way as yet, of expressing such degrees of hardness still there seems to be no difference of opinion on this point, and in practice various mixtures are used to get varying degrees of it.

Getting back to the other point, is there any information to be had that shows how far above the critical point we should go before quenching?

The critical point has one vital relation to hardening, for below it steel will not harden while above it it will. We are certain that there is a critical point, and we have means at hand whereby we can locate it when taking a heat. If we can establish its relation to the best quenching heat so as to use it as a guide in finding that point, steel can be hardened with a great deal more certainty. This much the scientist has shown.

In talking with men who are experts in tempering steel many of them say that they can tell by the look of a piece when it is hot enough to harden even though they do not know what the carbon content of the steel is. On pressing them for an explanation as to what this appearance is they do not appear to be able to give a definite answer. Some of these men had never heard of these critical points. All of them knew, of course, that a piece of steel would not harden if it was not heated hot enough, but they did not look at this temperature as being a fixed one for that steel. If I have gotten their ideas right they seemed to think that steel "toughened" somewhat at all heats, getting tougher and tougher as the heat got higher until finally that toughness was so hard that it could not be filed and then the steel was said to be hard. A higher heat gave more hardness, but as hardness increased toughness decreased until a point was reached where the steel became "brittle." This brittle steel was supposed to be very hard but lacked in tenacity.

Following this line of thought out, the belief was that the very toughest steel would not be hard, and that the toughness decreased as the hardness increased. The term "brittle" being used to express a state where the toughness had decreased to such an extent that the steel was not fit for use. It was not supposed that the decrease in toughness was altogether due to the hardness but that the temperature had much to do with it.

It was thought that certain mixtures used for quenching the steel made it much harder and also allowed it to be hardened at a lower temperature. Often these mixtures were used not so much to get greater hardness as to get the required hardness at a lower temperature so as to get greater toughness. I have been given to understand that there were steels that needed heating to a bright red to thoroughly harden them in water, but that they would harden "glass hard" in a secret mixture known to the teller when the heat was at the lowest point that could be called red in daylight.

One theory that I remember hearing was that steel would harden as soon as it was red hot if the proper mixture was used, and that quicksilver would do it at the lowest heat; it being able to harden a piece of steel as soon as it was hot enough to show red in the dark.

In a book published in 1903, and evidently intended for the steel worker, I do not find any mention of the critical point under any name. This book gives very full directions for hardening and tempering pieces of all kinds. It tells the precautions to take in heating and cooling. It tells of numerous baths, and gives their compositions. It gives the proper temperatures for drawing the temper for different classes of work. When information is looked for by which the heat for hardening may be known nothing definite is found. In one place the statement is made that the heat ranges from 1200 to 1400 degrees Fahrenheit.

A clear, bright red is recommended for use with a certain solution to be used in hardening long, slender work. For long taper reamers a bright cherry red is recommended. When using a lead bath for heating, a paste is recommended for keeping the lead from sticking to the steel, and when the paste melts the heat is said to be right. On another kind of work it was recommended that the articles be packed in a box and brought to a red heat and kept there for several hours. From the description this is not a case-hardening process, so done on account of the steel used, but is made necessary on account of the use to which the work is to be put.

From information, and lack of it, as found from this and other books written by and for steel workers it would appear that the hardening of a piece of steel is a mysterious and complicated ceremony not to be undertaken by anyone who has not been duly and regularly initiated into the mysteries thereof.

On the other hand the scientific metallurgist, in his exposition of the matter, makes it a matter of heating to a temperature that produces certain and definite changes, and then cooling from that temperature with more or less rapidity according to the results desired.

I have fallen in with the scientist's idea and hope that it is correct, as it would simplify matters very much. I have tested it to the extent of determining the fact that for the steel which I used (a piece of Crescent drill rod) the division between hardening and not hardening is an extremely narrow one, and that it is lower on a falling heat than on a rising one, and I have found that it is a very easy matter to locate this division.

With the critical points known and located, if the information is forthcoming as to the distance to go above them for different work or different steel it would seem as though the hardening of steel could be placed on a more reasonable basis for the ordinary steel worker.

It is altogether likely that the scientific steel worker has this information at hand, and it is certain that the scientific steel investigator can determine it if he desires to do so. Let us hope that one or the other of them will tell the rest of us.

The Evolution of the Magnetic Chuck

By O. S. Walker*

This article is to correct some mistaken impressions on the part of the general public in regard to the operation of magnetic chucks, and to illustrate some special applications, involving principles not generally understood. In order to get down to the root of the matter, it has seemed necessary to enter into details that are rudimentary to many, but which are introduced here for the benefit of the beginner and for the purpose of tracing the evolution of a magnetic chuck from its simplest form to its present state of development.

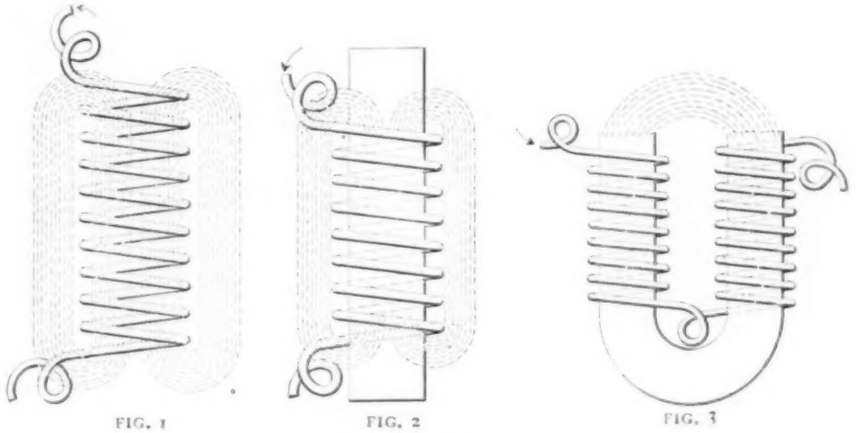

FIG. 1 FIG. 2 FIG. 3

MAGNETIC LINES OF FORCE

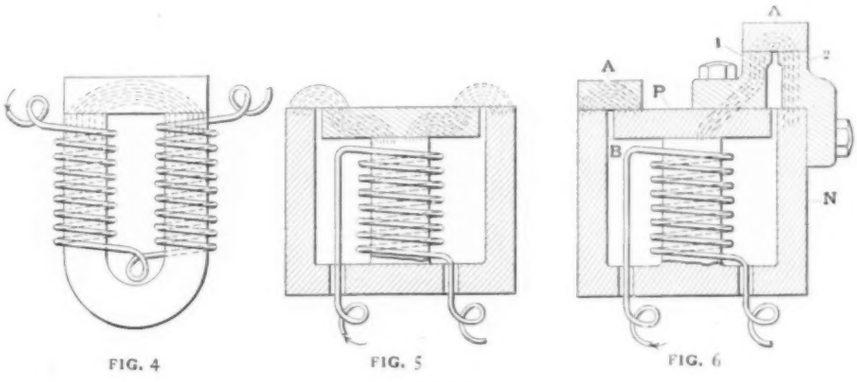

FIG. 4 FIG. 5 FIG. 6

APPLICATION TO A CHUCK

Nearly everyone at the present day has a general knowledge of the phenomena of electricity and magnetism, but I find that the knowledge of many of our inquirers on this subject is quite rudimentary and erroneous, one inquirer asking if the chucks are not dangerous to life and limb; and another asking if there is not danger of charging an iron building with magnetism, and whether or not the magnetism will give the operator a shock, etc.

For the benefit of such inquirers I will now state that magnetism is not dangerous to man, and that it attracts only iron and steel, from which it cannot be insulated by any known substance. There is less danger from the use of electricity in a chuck than in a motor, for the reason that the coils are entirely insulated and incased in the chuck shell, and the power is controlled through an ordinary switch.

The exact nature of electricity and magnetism is as great a mystery today as when the phenomenon was first discovered, and about the best definition of magnetism we can give is to say that it is an invisible force produced by an electric current, and more commonly by a current flowing in a coil or helix. Each end of the helix then becomes polarized and charged with positive or negative magnetic force. Between these poles, innumerable lines of force are constantly flowing, apparently in each direction through the center and outside the helix. In Fig. 1 a helix and the lines of force are graphically shown, where it will be seen that the force lines are indicated as reaching out in a wide radius through the air in their path over and around the helix. On account of the air resistance, the magnetic flow in Fig. 1 is not very intense.

On account of the strong affinity of magnetism for iron or steel, which forms the path of least resistance to the flow of the said lines, when we place a rod of iron in the center of the helix, as in Fig. 2, a greater intensity of magnetic flow is noticed. This is on account of the superior conductivity of iron, which is 100 times a better conductor of magnetism than the air. This characteristic of magnetism is what makes magnetic chucks possible, as when we lay a piece of iron or steel across the poles the magnetic lines immediately leap through the metal, and, if the piece is of sufficient cross section, practically all the lines are absorbed, and this answers the question regarding the magnetizing of an iron building, above referred to.

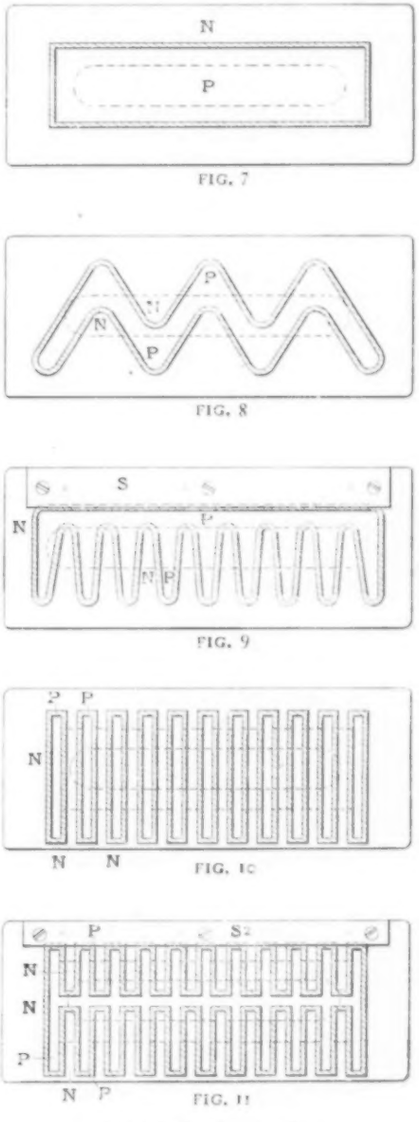

FIG. 7 FIG. 8 FIG. 9 FIG. 10 FIG. 11

FORMS OF POLE PIECE

The Holding of Iron and Steel

The intensity of the flow of the magnetic lines depends also on the length of the air space, or magnetic gap, across which the lines flow. A shortened air gap is provided by means of a U-shaped magnet, shown in Fig. 3, the poles being brought nearer together. Fig. 4 shows

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the same magnet with an armature bar laid across the poles, thus forming an entirely closed magnetic circuit, in which the lines of force may endlessly circulate, with but little free magnetism to be detected in the surrounding air. Fig. 4 might be called the ancestor of magnetic chucks. Fig. 5 shows a box form of magnet, and we have now arrived at the first practical form of magnetic chuck, in which the magnetizing coil is entirely inclosed in metal, the magnetic lines flowing mostly in the chuck shell, and an extremely narrow magnetic gap is formed, thus producing an intense flow of magnetic lines in a short arc across the air gap.

Fig. 6 shows the same style of chuck as Fig. 5, on the left-hand side of which is placed a piece of work *A*, which crosses the magnetic gap *B* and is strongly held in contact with the face of the chuck. On the right hand of the chuck is illustrated the method by which the magnetic lines may be deflected, or carried out of their natural course, by means of the raised pole pieces 1 and 2, attached to the positive and negative poles, respectively. On account of the superior conductivity of the iron as compared with the air in the space between the poles, the magnetic lines will readily follow this metallic path for some distance above the chuck face, and can be made to act in any angular direction. It must be borne in mind, however, that this extension of the magnetic circuit entails some loss of power, due to joints and leakage.

Figs. 7, 8, 9, 10 and 11 are plan views of magnetic chucks, showing various styles of face and contour of the interlocking polar surfaces and the magnetic gap lying between, which is filled with nonmagnetic metal. For the purposes of this description, all the inner poles will be considered positive, and marked *P*, and all the outer poles will be considered negative, and marked *N*.

Chuck For Large Work

In Fig. 7 is shown the simple form of chuck face, capable of holding large, thick pieces of work strongly or two separate, narrow pieces laid over the magnetic gap between *P* and *N*. This style of face, however, is not adapted to either small or thin work or for holding a multiplicity of pieces at one setting. Fig. 8 is a move in the direction of diffusing or distributing the magnetic power of the chuck, so that it will have a holding power exerted over many portions of its surface, and the work may cross the magnetic several times and be gripped more firmly.

Fig. 9 is an evolution from Fig. 8, and shows the poles with interlocking teeth formed on one side. There is also added the raised pole piece *S*, fastened to the straight side, which becomes polarized by contact with the chuck and forms a negative member. Therefore, when a piece of work is laid on the chuck face, one side crossing some of the interlocking polar faces and the other edge lying against the pole piece *S*, the holding power is obtained in two directions, viz., vertically and horizontally, and this adds greatly to the immovability of the work.

Fig. 10 illustrates the slotted face type of magnetic chucks, which has narrow rectangular openings, through which are inserted the positive teeth. These teeth are attached to a tie plate at the bottom, and the magnetic gap is filled with nonmagnetic metal. This style of face is well adapted for small pieces, and the spacing can be made quite small, and the negative teeth or cross bars will have sufficient stiffness. With this form of chuck, however, there is considerable leakage of magnetic force, and the projecting positive poles are necessarily weak.

While I have constructed many chucks with magnetic face like Fig. 10 for special work, the style shown in Fig. 11 is now a standard type. This form of face, if properly designed, gives best results for all-round work, a narrow central portion of the positive pole being brought flush with the chuck face, from which the teeth project on either side, interlocking with the inwardly projecting teeth of the positive pole. By a special arrangement of the tie plate underneath, the positive magnetism is sufficiently diverted in a lateral direction to obtain a side-holding force against the pole piece *S*, thus combining the advantages of Fig. 9 for side holding and the advantages of Fig. 10 for holding a multiplicity of pieces at one setting.

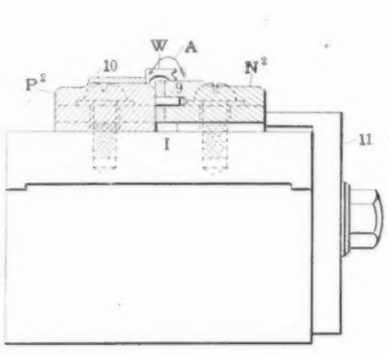


FIG. 17

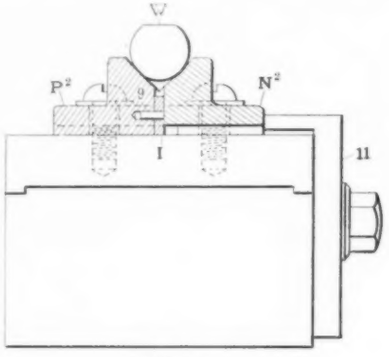


FIG. 19

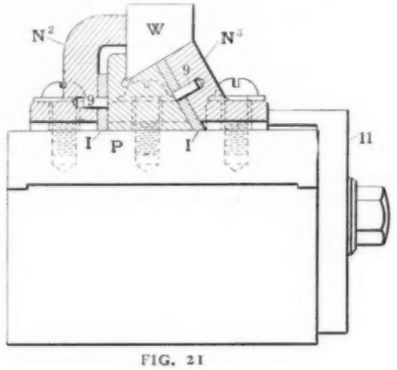


FIG. 21

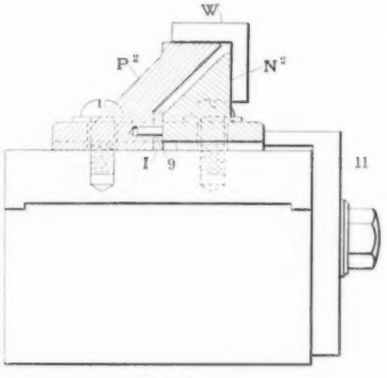


FIG. 18

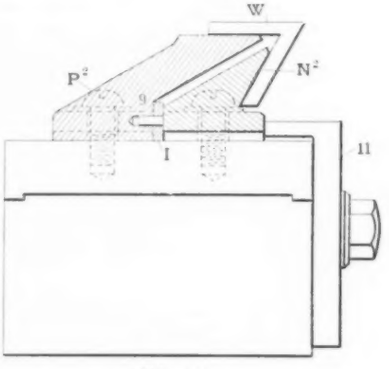


FIG. 20

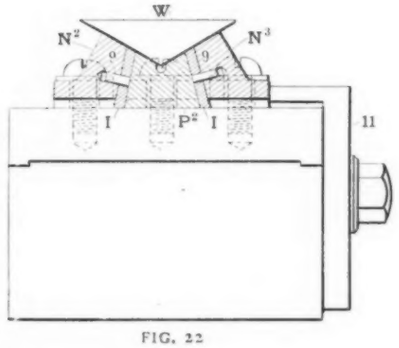


FIG. 22

HOLDING SPECIAL PIECES OF WORK

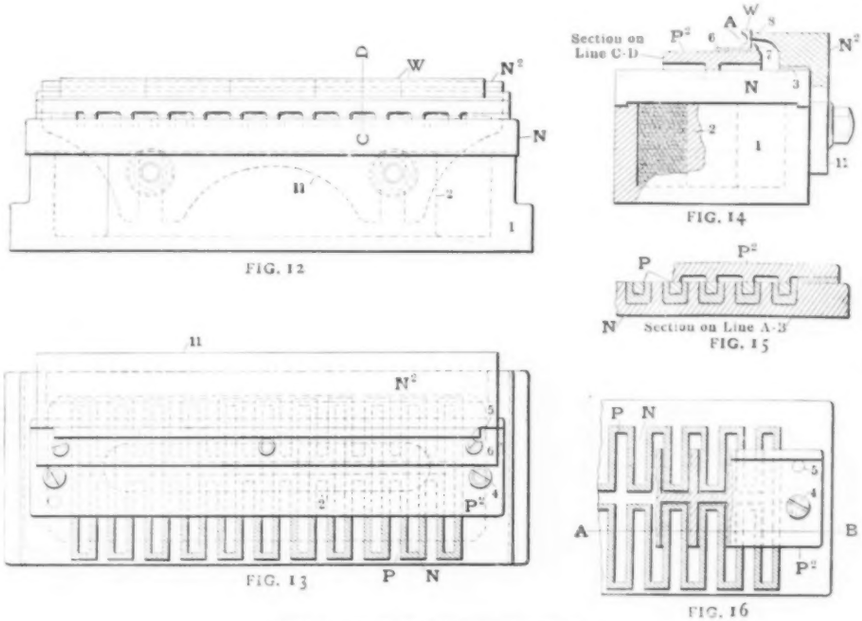
Holding Difficult Shapes

It being no part of the present article

to take up the subject of methods of holding regular flat work, the illustrations show the adaptations of standard type magnetic chucks for special work, or for work that is extremely difficult to hold by other means, but which we are able to hold on magnetic chucks by making use of the extended pole pieces to divert the magnetic power to the exact place where it is needed.

Figs. 12, 13, 14, 15, 16 and 17 illustrate one of the above chucks with special pole pieces for holding the piece of work *W*, an end view of which can be seen in Fig. 14 and which is about 1¾ inches long. It will be noticed that one side of this piece is concave and that the two edges of the piece are not of the same thickness.

It is desired to grind all parts of this piece except the ends and concave part, and the edges must be exactly square with the flat side. Bearing in mind that in rectangular work, only the adjacent sides will need squaring and that the opposite sides are ground parallel on top of the chuck, it will only be necessary to consider the detachable pole pieces, *N2* and *P2*, which aline the work and divert the magnetic lines in any direction to suit the surface being ground. In Figs. 12 to 14, it will be seen that *P2* has a series of recesses cut in its bottom side, causing it to make contact on the chuck face only with the positive polar teeth *P*, so that it is in effect a positive pole, and *N2* becomes a negative for the same reason (see Fig. 14). In Figs. 17 to 21, the pole pieces *N2* and *P2* are each recessed at the bottom to bear only on the corresponding pole of the chuck face.



DETAILS OF THE MAGNETIC CHUCK

The Operations

The first operation on the work *W* is to grind the flat side, and to do this it is mounted on *P2* and *N2*, as shown in Fig. 17, *N2* being higher than *P2*, to make up for the variation in thickness of the edges of the work, so that the side of the work to be ground will lie in a horizontal plane. The brass strip *I*, held by dowel pins, fills the magnetic gap, to exclude the dust, and a raised strip 10 is provided for alinement purposes.

The second operation is grinding one edge of the work square with the flat side, and this method is shown in Fig. 14, where *P2* is doweled and fastened to the chuck face, and *N2* is clamped to the back of the chuck, the former having an upward projecting lip 7 and the latter the horizontal projecting lip 8, the edges of which lie in the same vertical plane and are perpendicular to the chuck face. Against these magnetic vertical faces the work is placed, the bottom edge resting on a nonmagnetic strip 6, thus bringing the main magnetic holding force against the vertical surface, a slight downward attraction being obtained by means of beveling the lip 7. After one edge has been ground, the detachable pole pieces can be removed from the chuck, and the remainder of the operation is obvious. As will be seen from Figs. 12 and 13, a number of the above pieces can be held at the same setting.

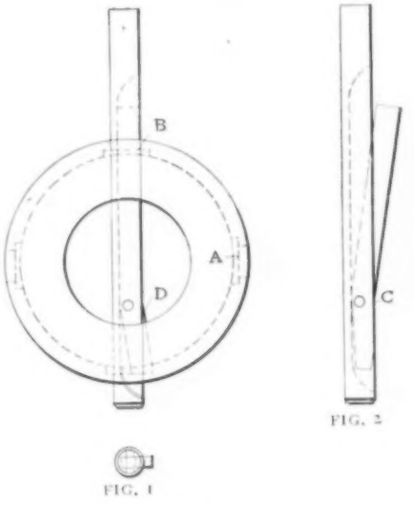
Figs. 18 to 21, inclusive, illustrate various arrangements of pole pieces for different shapes of work. Fig. 19 shows a method of holding a round rod. Figs. 18 and 20 show the holding of 90-degree and 60-degree angular strips, and Figs. 21 and 22 show the method employed in holding pieces with trapezoidal and triangular cross section.

It will probably not be apparent to the casual observer that in all the operations shown in Figs. 12 to 22, inclusive, each piece of work is so held that should it become displaced from any cause, the magnetic force will have a tendency to *pull it back into alinement*. This should be the guiding principle in designing pole-piece extensions, many other combinations of which may be found desirable in practice.

A Special Counterbore

By W. S. Mower

Having a lot of castings to be counterbored on the inside, as at *A*, Fig. 1, I designed the counterbore, shown, to do the work. Fig. 2 shows the tool as it is inserted in the hole at the top of the casting at *B*. As it enters the hole it strikes the incline on the cutter at *C*, which closes the upper end and throws the cutting end out. It is held in this position while doing the work by being in contact with the hole *B*. When the work is completed and the counterbore withdrawn far enough the incline at *D* strikes on the side of the hole *B* and throws the cutter back and allows it to be removed from the work. The drill press may be run continuously, as the counterbore may be inserted and removed without stopping.



A SPECIAL COUNTERBORE

The flat-wheel evil is known to everyone who rides in cars, but few realize the enormous energy developed by a flat spot in a car wheel. Professor Hancock, of Purdue University, according to the *Scientific American*, finds that a flat spot 2½ inches long on a 33-inch wheel, carrying a load of 6000 pounds at 30 miles per hour, will deliver a blow to the rail of more than a 1000 foot-pounds. The same flat wheel supporting a 55-ton interurban car running at 60 miles per hour, would deliver a blow with an energy of 9500 foot-pounds. Such a flat spot would be produced by wearing off less than 0.05 inch of metal.

Special Boring Fixture for Bench Lathe Heads

The Cataract Lathe Heads, Footstocks, Turrets and Other Parts Are Finished by Boring on an Accurately Constructed Bench Machine

SPECIAL CORRESPONDENCE

The illustrations show a special machine designed by Franklin Hardinge, of Hardinge Bros., Chicago, for boring the heads and tailstocks, turrets and other fixtures for the Cataract bench lathe.

Fig. 1 shows this machine ready to perform the operation of boring out the housings for the boxes of the lathe. As the spindle journal of the Cataract lathe is parallel, a special device had to be made whereby the taper seats in the lathe head could be bored with accuracy and adjustment for the journal thus obtained.

The Headstock Construction

The headstock casting is shown in place on the boring machine in Fig. 1. The form of the bearing seat in the head will be seen in Fig. 2, which is a sectional drawing of the No. 3 Cataract head. With this housing, a bushing taper on the outside and parallel on the inside is made up 1/64 inch larger than the spindle that revolves within it. This is compressed this 1/64 inch before coming in contact with the spindle, the object being to make it hug the seat in the housing. The slots in this bearing are arranged as shown so as to keep a uniform pressure on each section, it being divided into ten sections or wedges; and being adjusted by one screw, the head of which fits into a slot at the bottom of the bearing, it is possible to push this sleeve up on the angle or withdraw it at will. It is, therefore, possible to get as fine an adjustment on the journal as desired.

Boring the Heads

The boring device illustrated in Fig. 1 was made with great care and precision and the desired result is accomplished with ease with this special fixture. It consists of a boring spindle which is revolved by worm and worm wheel in properly fitted and protected bearings in head *C* and instead of feeding parallel, the boring bar proper, *A* is fed out of the spindle at an angle of 4 degrees by the operation of the star wheel *B* which travels against a movable contact piece seen just under the spindle. When the bar is fed to its extreme length it automatically shifts this contact piece and disengages the feed. The finger *E* effects a disconnection of the feed nut so that the bar *A* can be returned to the proper starting point instantly and the nut connected again. The feeds are necessarily fine and slow.

In the illustration, Fig. 1, the head casting *D* is drawn back out of position to show the boring bar *A* better. While in operation it is placed quite close to the boring head, against a stop. The head casting is, of course, reversed for the boring of the other end.

With this arrangement all sizes of the bench-lathe heads can be bored, from the smallest to the largest, and duplication of centers and interchangeability of parts can be obtained. In fact a scraper never has to be applied to the heads, tailstocks or other parts after they are put through this machine for alinement.

Tailstock and Turret Operations

Fig. 3 shows the operation of boring the tailstock. While the operation in Fig. 1 requires only the rotary movement of the driving spindle through which the taper boring bar itself is fed endwise, as already explained, the operation shown in Fig. 3 calls for a longitudinal feed as well as a rotary movement of the driver spindle. This feeding movement is secured by worm gearing, pinion and rack, located at the left-hand end of the fixture; the drive for both the feeding and the rotating movements being derived through the medium of the round belts passing over the two small pulleys shown at the rear of the head. An automatic stop is also provided

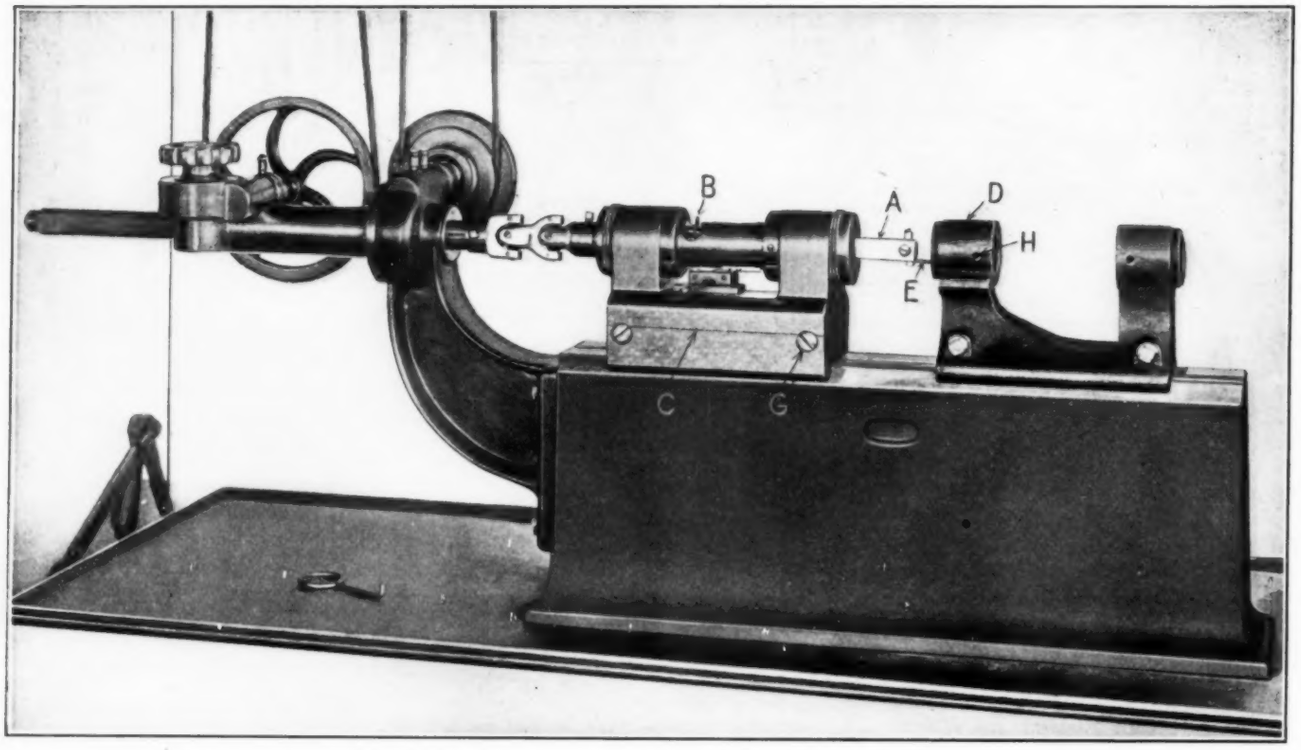


FIG. 1. BORING TAPER SEATS IN CATARACT BENCH LATHE HEADS

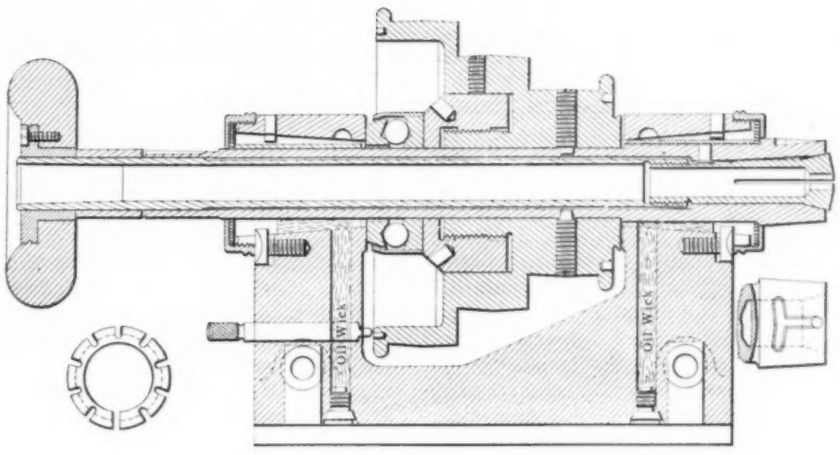


FIG. 2. SECTIONAL VIEW OF NO. 3 CATARACT LATHE HEAD

for the feed arrangement when used as in Fig. 3. Fig. 4 shows the method of boring the turret holes with the same pair of heads for the bar as shown at *F F*, Fig. 3, for boring the tailstock.

Master Blocks and Their Use

For making such a set of heads it was necessary to build also other heads (or master blocks) on a different plan, having the holes for the bushings square rather than round as in the case of those in Figs. 1, 3 and 4. This was done with the greatest care so that a test plug could be laid into these square recesses and turned and reversed in any position without detecting any error.

Into these master heads, or blocks after the square openings were properly scraped, a round bushing was fitted and the proper hight secured by measuring at both ends of the master boring bar. The master heads were then ready for taking the final cuts in the heads *C*, Fig. 1, and *F F*, Fig. 3, the object being to bore the three heads at the same time. Boring head *C*, Fig. 1, as will be observed, is made in two parts and provided with four screws *G* which hold from the bottom as well as the sides. After the boring of heads *C F F* it was necessary to drop the head *C* 0.001 inch, so during the boring operation a piece of tin foil was placed between the two parts of the head and subsequently removed. The object of this course was to bring the bore of the fixtures *F F* 0.001 inch higher than that of the head *C*, in order to bore the tailstock of the bench lathes 0.001 inch higher than the head. All the Hardinge machines are finished with the tailstock this amount higher, as the headstock is scarcely ever removed, while the tailstock is constantly slipped along the bed, and it is the experience of the makers that it is best, therefore, to manufacture the lathe so that the tailstock has 0.001 inch wear before it is down to zero or the true center, and 0.001 inch further wear before it is as far below center as it was above center when first bored out. This allowance, it is believed, keeps the lathe sufficiently and practically accurate for the greatest practicable length of time.

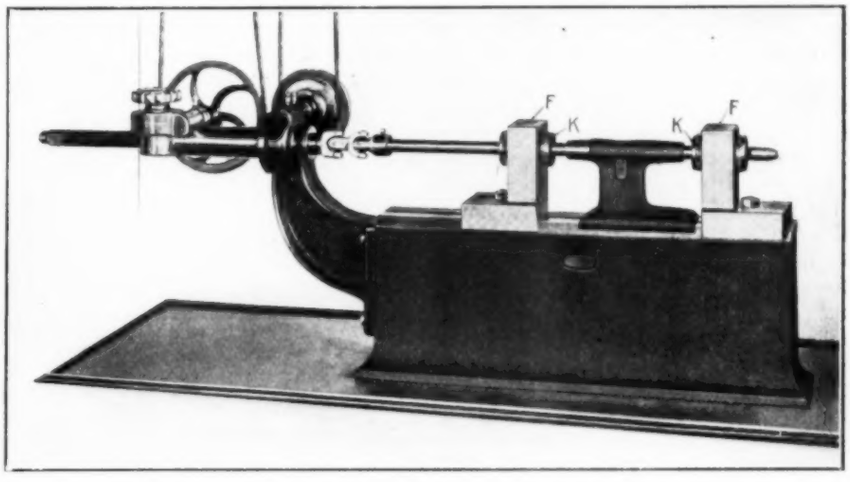


FIG. 3. BORING OUT THE TAILSTOCK

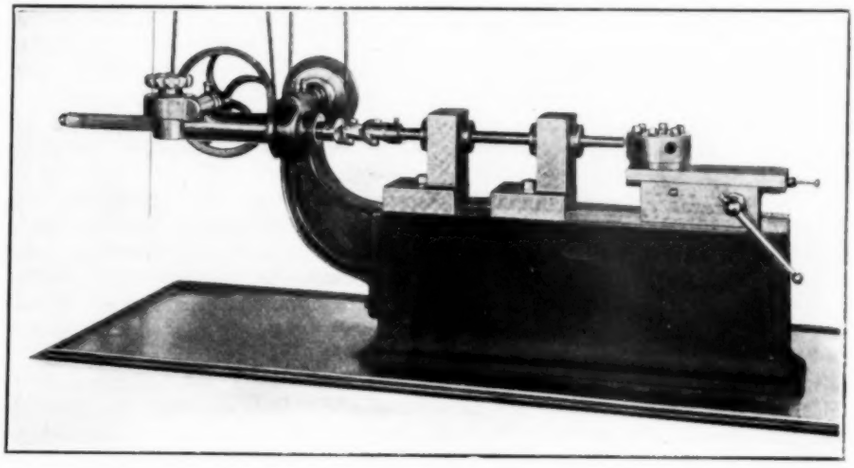


FIG. 4. BORING TURRET HOLES

Spindle Protection and Lubrication

In connection with Fig. 2, it will be of interest to call attention to the manner in which the spindle bearings of this bench lathe are lubricated and protected from dust and grit. Large oil grooves are formed within each head housing, to which lubricant is supplied by means of oil cups screwed in at the side. The oil passes from the large oil grooves down a channel and against the lower end of a wick and then passes up the wick, the upper portion of which rests against the spindle so that the oil is wiped from the wick by the rotating spindle. A felt washer and dust cap are applied as shown at each end of the lathe head, thus effectually excluding dirt, emery dust, etc. This sectional drawing also shows the ball thrust bearing and the means of adjustment.

According to a report just issued, the shutting down of the two American Niagara water-power plants on several occasions last year showed that these plants in diverting 8000 cubic feet of water per second lowered the water level on the American side only 2/5 inch, the normal flow level of the American falls being about 19 inches. On the other hand, the level of the river at Grass island was lowered 3¼ inches, and near the Ontario intake on the Canadian side about 1¼ inches.

Remarkable Facts in Tempering Tool Steels

Gain in Strength Not in Proportion to Loss of Hardness. Avoid Brown Temper. Facts Found by Scleroscope and Compound-Stress Machine

BY ALBERT F. SHORE*

Still more new data on tools and tool steel! It is a very remarkable fact that in spite of the truly liberal attention this subject is getting from numerous authors, and men who practice the art, alert people whose profits lie in the capacity of their tools, should be ever ready to shrug their shoulders at what is suggested to them and yet eagerly scour every mechanical magazine for more and more information—something NEW. What is this special information that we all seek? The question was put to a manufacturer who reluctantly dumped out about a carload of worn-out and fractured dies as the result of three-fourths of a year's work. He replied, "We use up a large quantity of tool steel, and make hundreds of dies every year for cold working in steel and other metals, and we could greatly extend our operations were we not limited so much by the capacity of our dies. Some of these dies are very expensive. The work they do is for quantity rather than quality in some cases, while in others the product must be accurate and in quantity to insure fair profits. We have seen some of these dies, all doing the same class of work, outlast ten others, although, of course, this happens very rarely. We have adequate means for hardening, and so far as we know, we do it right, yet it so happens that not all tools, though treated carefully, are capable of doing a fair amount of work. This has always puzzled us and we are ever anxious to see some light shed on this phase of the question."

This very natural tendency has aroused, and attracted much attention toward the perfection of precision-measuring instruments. A number of these have been brought out recently, and each in due turn has been looked to as a new hope if not a step in the right direction—the faithful predetermination of such high efficiencies as are obtained every now and then by mere chance. In this connection, pyrometers have been tried out to ascertain whether or not uniform success was hinged on uniform and correct heat-treatment of tool steel. While the pyrometer is indispensable if properly applied, it was discovered repeatedly that uniform heat-treatment was not alone essential to uniform success, for still were tools produced of widely variable efficiency. Was it in the tempering of correctly hardened steel?

This question was raised by a number of engineers and remained practically unanswered, although many hardness tests were made from time to time. The reason that the hardness tests as formerly made did not solve the problem, it was thought, was because the methods available would not disclose the slight differences which yet had important bearings. Thus when the scleroscope appeared and began to be adopted extensively as a very sensitive instrument for testing hardened steel faithfully, the question was taken up with renewed hope and enthusiasm, and thenceforth the question was put in different forms to the manufacture of that machine.

To what hardness shall we temper a die subjected to great strains and shock? Is the hardness a measure of value in predetermining the efficiency of a tap or other tool which is usually required to resist great strains and which must yet be hard enough to hold an edge in the hard material? or to what hardness should we draw the temper of a die or punch cutting hard materials without enormous strains, scaly, but soft materials, etc.?

NOT ANSWERABLE FROM THE PRESENT STATUS OF SCIENCE

As part of the success of the scleroscope was dependent on our ability to successfully apply it to this higher art of tool making, we naturally began a careful systematic inquiry into existing conditions. If any fallacy existed among the accepted standards which may tend to mislead in the outset, we were determined to know it. Among the first things that one would necessarily require in addition to hardness-testing means in conducting researches in this line, would be a strength-testing machine of the proper design, and capable of imitating the true class of strains to which the tools in question are subjected in actual service. Such an apparatus we were unable to find on the open market and thus we found it expedient to design and build our own strength-testing machine which, used in conjunction with the known measured hardness, would finally enable us to get a line on the serious questions before us.

I had pointed out in these columns more than a year ago, that so long as tool steel varies greatly in hardening power it was not feasible to give any fixed hardness number to which a die may be drawn in temper without first taking into consideration the original degree to which the steel could harden. The law that the tool must be about three times harder than the material it is to cut, which was discovered by aid of the scleroscope, was also then promulgated, and which has since been widely observed. Now by observing this rule it is very easy for anyone to simply measure the hardness of the stock to be cut, multiply it by 3, and then temper the tool accordingly, and, of course, it must hold its edge. But this is not sufficient, for in high-duty tools the strength factor is just as important as that of hardness and, therefore, it remained for us to point out also the maximum strength accompanying it, and just how it may be obtained. Assuming that a tap hardened to about 100, the average for

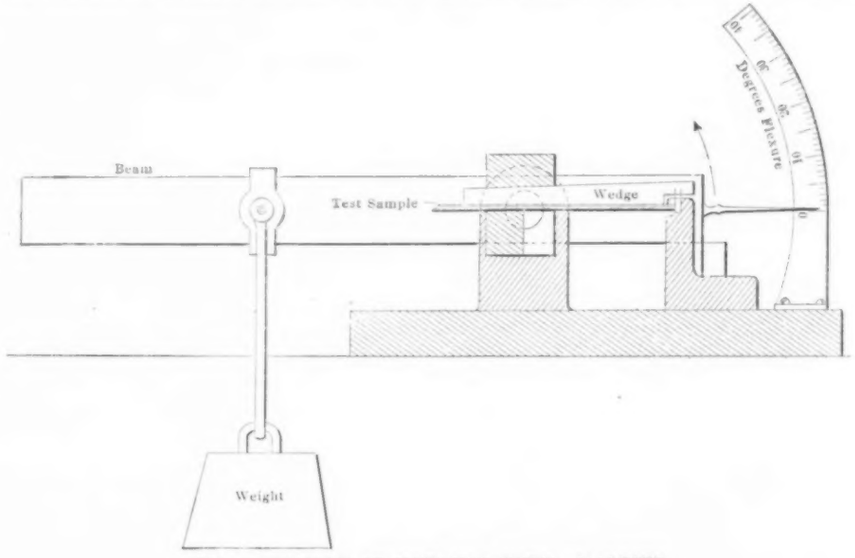


FIG. 1. DIAGRAM OF COMPOUND-STRESS MACHINE

*Shore Instrument Manufacturing Company, 226 West Twenty-fourth street, New York City.

hardened steel, and we were to cut steel with it 25 hard, it may be drawn in temper down to 90 hard, or about the same as a drill.

Now since a tap is subjected to a greater strain and we have plenty of hardness to spare, we naturally draw the temper still more, sacrificing, as it were, hardness for strength, and thus often taps and dies are let down to 85 degrees in hardness, which give very high efficiencies in practice because very heavy cuts can be taken without breaking them, and they will still hold an edge so long as no harder stock is worked with them. This procedure we advocated from the first although it has met with some criticism and the following is an example: A lot of pipe-threading dies were brought in which were stripped and more or less broken and yet they measured 85 hard by the scleroscope, the prescribed hardness for a very strong tap or die. An examination showed that instead of being tempered to a blue for that hardness these tools were only light straw, and could not be filed at all. This suggested crystallization due to rank overheating, and this was proved in the following way: by the coarse crystal, and by annealing a sample, and rehardening with the proper quenching heat. The sample now showed 100 hard, and after drawing down to 85, was oxidized blue and could be filed some and, of course, was exceedingly strong. We, in this instance, were able to show the correctness of our claims for sacrificing hardness for strength to a certain point or until three times the hardness of the material to be cut is reached. But still we were shown in that some instances, although the steel was heat-treated right and tempered right as above, it was brittle and quite useless after sacrificing hardness for strength. We now concluded that this decrepancy was due to the steel itself, and only the most painstaking research work would explain the mystery.

The Compound-stress Testing Machine

Failing to find the necessary apparatus in the market, we at once designed and built a compound-stress testing machine. The ordinary pull-testing machine now in universal use simply pulls a piece of metal apart like a string until it stretches and parts. The point where permanent stretching begins with a certain strain is called elastic limit or yield point, the total stretch elongation; while the parting of the piece is the ultimate strength. These machines simply pull or stretch the whole area or cross section of the test bar and therefore it is known as a single-stress machine. Unfortunately very few tools or parts of machines are alone subjected to such strains as measured by the single-stress tester and the real strain, as a matter of fact is a compound one. A drill, for example, is subjected to torsion, stretch and compression. Punches and dies are almost invariably subjected to compound stresses consisting usually of stretch and compression. The machine we wanted was one that would subject samples to stretch and compression at the same time as by bending a bar or strip of metal. In this instance about one-half of the cross section of the bar is under compression while the other half is stretched, provided the resistance to each stress is about the same. But it is not always the same, and that is where the older method of testing failed to give a clear record of the real power of a metal when put to ordinary service.

The machine we built is shown in the diagram, Fig. 1, and consists of a graduated beam and adjustable weight as on a standard weight scale. In the pivot bar of the beam a square opening is made to receive the strip to be tested. The strip is so situated that the bend may take place in the exact center of the pivot block and in which it is held by a graduated wedge. This wedge has a stop pin on its thicker end which always determines how far the strip should project from the point of clamping, or where it is to bend. This length, regardless of variations in thickness, is always 25 times that of its thickness. Graduations on the wedge show how much of the bending weight must be removed to allow strength curves of always the same length for the same material at different thicknesses. When now a test is made the weight is gradually screwed out toward the end of the beam and as the weight thus increases, the strip being anchored on its outer end fast to the block, it bends.

This bending is indicated by a needle against a protractor scale. Up to the yield point of the metal under test, it develops that for each pound of weight added to the strain a proportionate amount of flexure is shown on the protractor in minutes or degrees. Plotted out on a curve chart a perfectly straight line results and so continues up to the elastic limit. (See charts, Figs. 2, 3, 4, 5, 6, 7) and thereafter, although the weight is added gradually as before it suddenly sinks down causing a very sudden rise in the curve, showing as it were that there is now stretch, reduction of area and the ultimate strength is soon reached. In hard and tempered steels it will be seen by referring to Figs. 2, 3, 4 and 5 that the lines run quite straight and end abruptly. This is where the test piece broke for it was too hard to stretch or compress to any considerable extent.

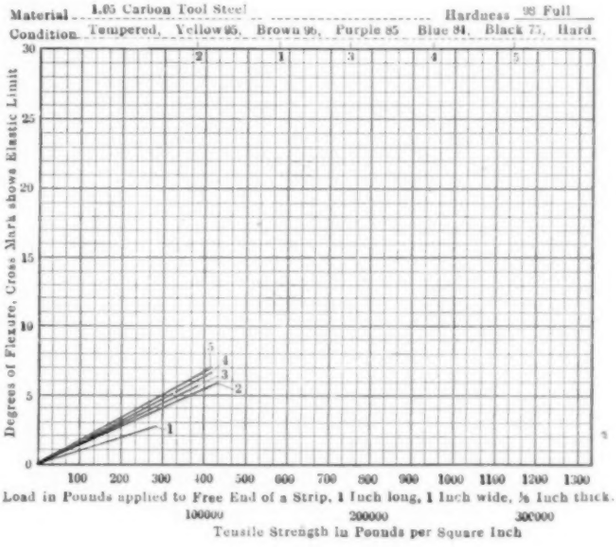

Material 1.05 Carbon Tool Steel Hardness 98 Full
Condition Tempered, Yellow 85, Brown 90, Purple 85 Blue 84, Black 75, Hard
Degrees of Flexure, Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ⅛ Inch thick.
Tensile Strength in Pounds per Square Inch

FIG. 2

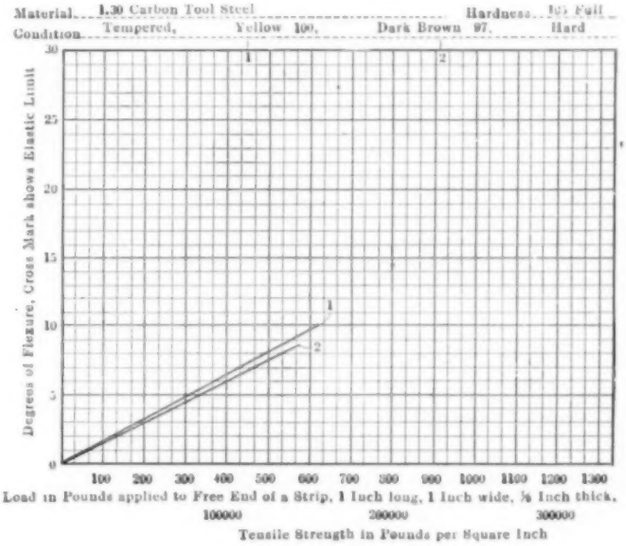

Material 1.30 Carbon Tool Steel Hardness 103 Full
Condition Tempered, Yellow 100, Dark Brown 97, Hard
Degrees of Flexure, Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ⅛ Inch thick.
Tensile Strength in Pounds per Square Inch

FIG. 3

CHARTS OF TESTS MADE ON TOOL STEELS WITH THE COMPOUND-STRESS MACHINE AND SCLEROSCOPE

Fallacy of the Temper Range

With this special machine at our command we were at last in a position to answer the previous question, "To what hardness shall we draw the temper of tools

for certain classes of work involving great strains." We subsequently gathered a large variety of tool steels and prepared a number of test pieces of each.

Each class of steel was tested to see what temperature was requisite for the best and highest hardening and for this purpose a special instrument was devised, while the scleroscope was used to measure the resultant hardnesses. Each set of test bars was now hardened with the greatest care so as to get the same hardness and grain. Each piece was now measured to see if all were alike in hardness and if one varied 2 per cent. it was thrown out as unreliable for the final break test after tempering. This latter process consisted of drawing one piece of each set to the following temperatures: 470, 520, 535 and 600 degrees Fahrenheit; they were now ready for the break test.

The first of these pieces we ever tested was a medium grade of carbon steel and it was drawn to a dark straw (470 degrees) and the result carefully recorded; the second piece was tempered to a brown (520 degrees) but somehow it broke sooner than the first piece; this fact seemed strange indeed. The third piece, purple (535 degrees) temper, showed but very little stronger than the piece at dark straw color. Had we not supposed that the unnatural results were due to crystallization we should have been greatly surprised, as, however a closer inspection revealed that there was no crystallization, we continued the series of experiments before us, to see what would develop in other grades of steel. The last piece of the first set tempered to a blue (600 degrees) showed a surprisingly little gain in strength over the one at only dark straw color. The initial hardness and the hardness remaining after drawing the temper of each is shown in chart, Fig. 2.

Our next test was on carbon steel of about 1.30 carbon. There were two pieces taken from the same bar; they were hardened and then tempered to dark straw (470 Fahrenheit) for one and brown at (520 Fahrenheit) for the other and then tested for hardness and also strength to see whether or not the former experiment could be duplicated, that is, that the piece reheated about 50 degrees higher than the one at (470 Fahrenheit) would in spite of all beliefs to the contrary, fail to show greater strength if not even less, than the harder one. The chart, Fig. 3, shows just what results were obtained by the hardness tester and the strength measurement; again did the softer piece—the one which was reheated most—fail to carry as great a load and give as great a flexure without fracture as the harder or less tempered piece.

Next we tried a low-carbon (90 carbon) steel which consisted of a number of pieces cut from the same bar hardened all alike as usual and tempered also as before and as chart, Fig. 4, clearly shows we could get no change in the surprising results previously noted.

The distinctive feature in low-carbon steel, as in this instance, seems to be its immunity to the gaining of strength after reheating to about 475 degrees Fahrenheit. The steels so far discussed are of the low- and medium-carbon series, which are in most general use because as alleged, they are not so readily burned, do not crack, and resist shock better than high-carbon steels.

The next test we made was on a very high carbon steel (1.65 carbon), usually recommended for turning chilled rolls, etc., where great hardness is required in the tool. The results obtained in this instance are as indicated in chart, Fig. 5, and are all out of proportion to those following tests in low-carbon steels insofar as strength values are concerned, although the hardness is not much greater. Unlike steels of a lower grade, this special grade comparatively showed a most radical gain in strength with the progress of temper-drawing save for the same point at which all the other classes of steel grew weak and brittle, that is, at about 520 degrees Fahrenheit, or dark brown.

At this stage of our progress it looked as though we had made a distinct discovery in the science of tempering steel, but as we all know, particularly this temper, found, as it were, to be most brittle and weak, is the same recommended by our textbooks as a *hard temper adapted to resist shocks*, we were still reluctant to accept the new conditions. "This looks like a revolution in tool making," said some of the experts. We were at first greatly perplexed to account for the discrepancy and then changed our tactics to determine whether or not carbon in steel is the controlling factor in this connection.

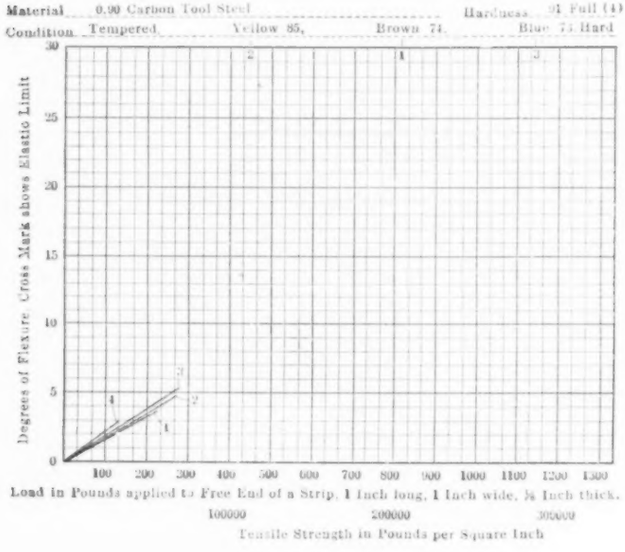

Material 0.90 Carbon Tool Steel Hardness 91 Full (4)
Condition Tempered, Yellow 85, Brown 74, Blue 71 Hard
Degrees of Flexure. Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ½ Inch thick.
Tensile Strength in Pounds per Square Inch

FIG. 4.

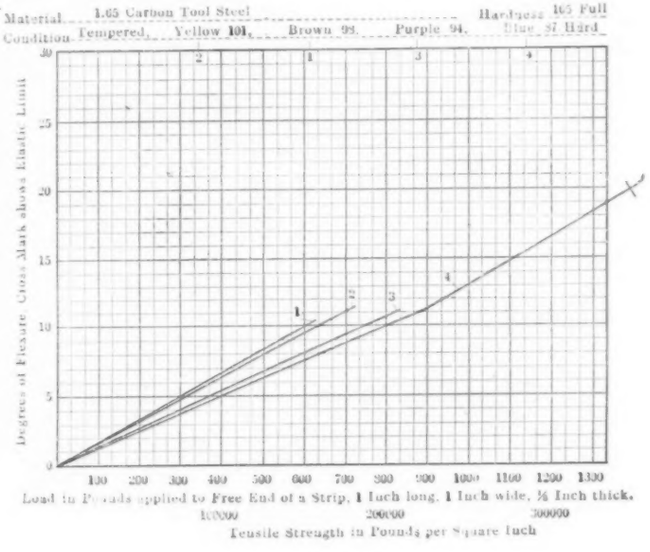

Material 1.65 Carbon Tool Steel Hardness 105 Full
Condition Tempered, Yellow 101, Brown 98, Purple 94, Blue 91 Hard
Degrees of Flexure. Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ½ Inch thick.
Tensile Strength in Pounds per Square Inch

FIG. 5.

CHARTS OF TESTS MADE ON TOOL STEELS WITH THE COMPOUND-STRESS MACHINE AND SCLEROSCOPE

High-speed steel air-hardened at a low heat (rolling heat) having a hardness of 100 by the scleroscope was thus carefully tempered by reheating to 470 degrees Fahrenheit for one piece, and 520 degrees Fahrenheit for the other. The steel in this condition responded, lost hardness as carbon steel would, and in spite of the very high percentage of tungsten and chromium, the piece tempered most was weaker, more brittle, and like our carbon-steel experiments failed when tested for strength with less strain than the harder piece could endure. This experiment showed that unless high-speed steel is given a very high heat in hardening, it is subject to the nature of carbon, and truly lacks the valuable properties inherent in the very same steel when properly heat-treated.

In this latter instance we went a little into detail and tried out more samples cut from the same bar after hardening

them in the manner directed by the manufacturers, that is, at a white heat. Some of these pieces were quenched in kerosene and others were cooled in an air blast; two pieces of either kind were tested for hardness and all showed about 98 hard; following this all were tested to destruction as in all previous cases to determine their strength. Here it developed that the air-hardened samples were strongest by about 12 per cent., while their average strength was, when full hard, about equal to a fairly good carbon steel tempered to a straw color. After drawing the temper on some similarly treated samples to a good blue, the scleroscope disclosed that the original hardness was very little affected, and likewise the breaking machine indicated little gain in strength as the result of tempering.

These findings soon convinced us that at low hardening heats high-speed steel while surely stronger, is much like plain carbon steel, and without doubt that element is the determining factor, while at the highest heats tungsten assumes control, and as this is a very refractive metal, when properly combined with iron, etc., is very little influenced by a reheating temperature less than 800 degrees Fahrenheit.

The next steel we tried out was a special one for tools, and of the following composition: chromium, 3½ per cent.; carbon, 1 per cent. The great excess of chromium permitted itself to become master of the carbon as at first shown by the high heat, 1600 degrees Fahrenheit required to harden it.

The initial hardening power of this steel was 104, and when tempered and tested for strength as usual, developed curves, as in Fig. 6, where it will be seen that the gain in strength was quite uniform with the progress of temper-drawing, although as the hardness did not fall in proportion, it left us in doubt, as a new steel to us, whether or not we had treated it exactly right when it was hardened. Reference to chart, Fig. 6, will nevertheless show that this steel, while it had a tendency to warp some, was indeed a very powerful metal at a fair hardness.

The next steel tried out was a vanadium-carbon bar intended for axles and shafts. This steel hardened easily, suggesting that the carbon in it had full sway, and the vanadium present served to aid it in its freedom by causing a closer union of the iron and carbon during the quenching process. This theory appears to be amply verified by the strength tests which followed, and when, as before, in other carbon steels, a peculiar brittle condition was developed by drawing the temper past a yellow to a dark brown (520 degrees Fahrenheit). This condition is clearly shown by the curves in the chart, Fig. 7. Here it will be noted that when this steel is full hard (92) it is as brittle as plain low-carbon tool steel, but when reheated to 470 degrees Fahrenheit, an almost incredible gain in strength is obtained, and in spite of the high hardness (86) and stiffness, the specimen did not fracture at the elastic limit point, but took on a permanent set. By further reheating from the said 470 degrees to about 520, the hardness dropped from 86 to 84, but instead of there being a gain in ductility, there was a loss of it and the piece broke at the elastic limit.

We regarded these results in particular, as a most convincing argument in support of the then incipient theory that the line of strength gain in temper drawing is not in a uniform progression with the application of more and more heat before a spring temper is obtained at a light blue. In order to convince ourselves that there is thus a danger point always to be avoided in tempering tools, we gathered and tested out a great many different kinds of steels, and with the result that in all cases where we could harden each piece perfectly uniform in its relation to each other, a yellow temper is stronger or as strong as one dark brown; in many cases the former is stronger than any other following it, while in steel above 1.65 carbon, the old temper range may remain intact, that is, there is a constant gain of strength with the progress of reheating, although at a blue temper there is no great gain in strength as in steel of a little lower carbon.

The chart, Fig. 8, shows the curves of Figs. 2 to 7, inclusive, plotted together. Critical point in the curves shows plainly. Fig. 9 shows the grain of the fracture of 1.65 carbon steel and 0.90 carbon steel referring to charts, Figs. 4 and 5.

Practical Application

Having proceeded to a stage where it was readily apparent that the relation of strength to hardness depended, for the most part, on the chemical nature of the steel, we unhappily drifted into another and none the less perplexing phase of the general problem. How shall we predetermine, in the shop, whether or not one or another steel is suitable for a given purpose? Must the sample be analyzed by a chemist?

In order to answer this question, I decided that it would be best to pursue a method as nearly mechanical as possible in order to eliminate such errors as are likely to occur in the laboratory, for these would tend to render the system useless in ordinary practice. Among the dangers thus to be guarded against, are the often wide differences in the dynamic or mechanical effect in metals of different heats, but which still show the same chemical analysis. In this connection, a practical example will best define the situation. In a steel analysis, we may determine, for example, that the carbon content is 1.25,

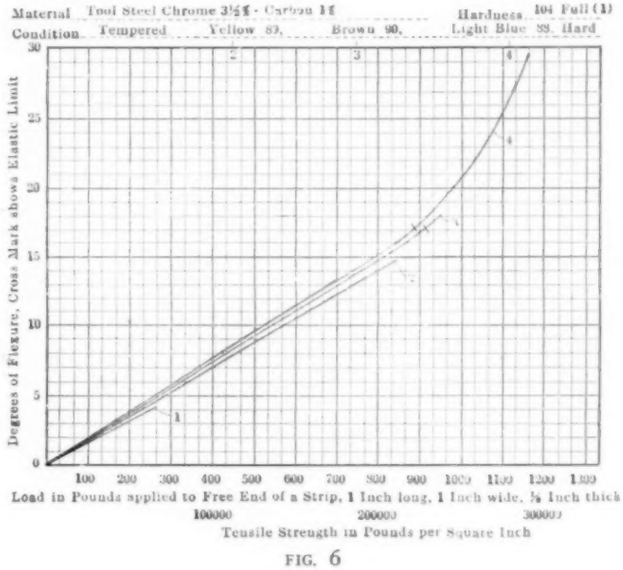

Material Tool Steel Chrome 3½% - Carbon 1% Hardness 104 Full (1)
Condition Tempered Yellow 83, Brown 90, Light Blue 88, Hard
Degrees of Flexure, Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ⅜ Inch thick
Tensile Strength in Pounds per Square Inch

FIG. 6

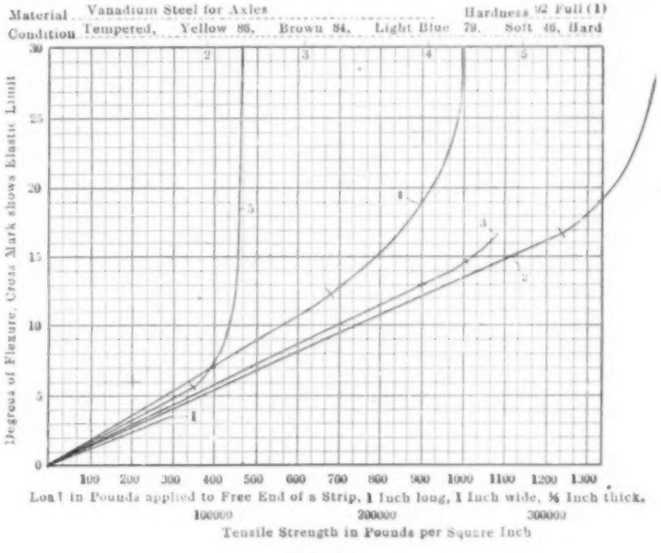

Material Vanadium Steel for Axles Hardness 92 Full (1)
Condition Tempered, Yellow 88, Brown 84, Light Blue 79, Soft 46, Hard
Degrees of Flexure, Cross Mark shows Elastic Limit
Load in Pounds applied to Free End of a Strip, 1 Inch long, 1 Inch wide, ⅜ Inch thick.
Tensile Strength in Pounds per Square Inch

FIG. 7

CHARTS OF TESTS MADE ON ALLOY STEELS WITH THE COMPOUND-STRESS MACHINE AND SCLEROSCOPE

while it is only capable of doing the work of steel having an actual carbon content of 1 per cent. This shortcoming is probably due to the presence of carbonic oxide to such an extent that really only 1 per cent. is available to combine with the iron in the hardening, while the other may either be neutral or oppose the hardening.

In chemistry, it is unfortunate that one of the most important elements, as carbon in steel, is most difficult to analyze and one of the most accurate methods fails to distinguish the difference between available carbon and carbonic oxide. Much hope has been held that the scleroscope, owing to its absolute sensitiveness, would become of great assistance to chemists in that carbon content may be determined by the progressive hardening of the steel after quenching. This hope has been realized in steels running in carbon of 0.05, to 0.045, but not as high as 0.50 for the reason that when this steel is pure and the carbon is all available, it will harden as much as tool steel of about 1 per cent. carbon, if the pieces are not too large. These inevitable conditions, obviously ruled out all hope of determining the available carbon contents in the higher carbon steels by measuring the uniform progression of hardening power.

But as the carbon in steel runs above 0.90, which is the starting point for tool steels, happily enough, a curious and very interesting phenomenon may be noted by quenching the steel at a light yellow heat, about 1800 degrees Fahrenheit. In this test, obviously, the steel must crystallize more or less. This crystallization is greater and greater as the carbon content becomes higher. Likewise the drop in measured hardness is progressive. Steel of about 0.90 carbon thus shows a loss in hardness of about 2 or 3 degrees by the scleroscope; while steel of 1.75 carbon loses 60 degrees of its hardness as available when hardened at a low heat. A test bar thus made from 1.75 carbon steel may appear perfectly hard by the file test on both ends no matter how one end may have been overheated, while yet when properly measured, the hardness may indicate 110 degrees on one end and only 50 on the other.

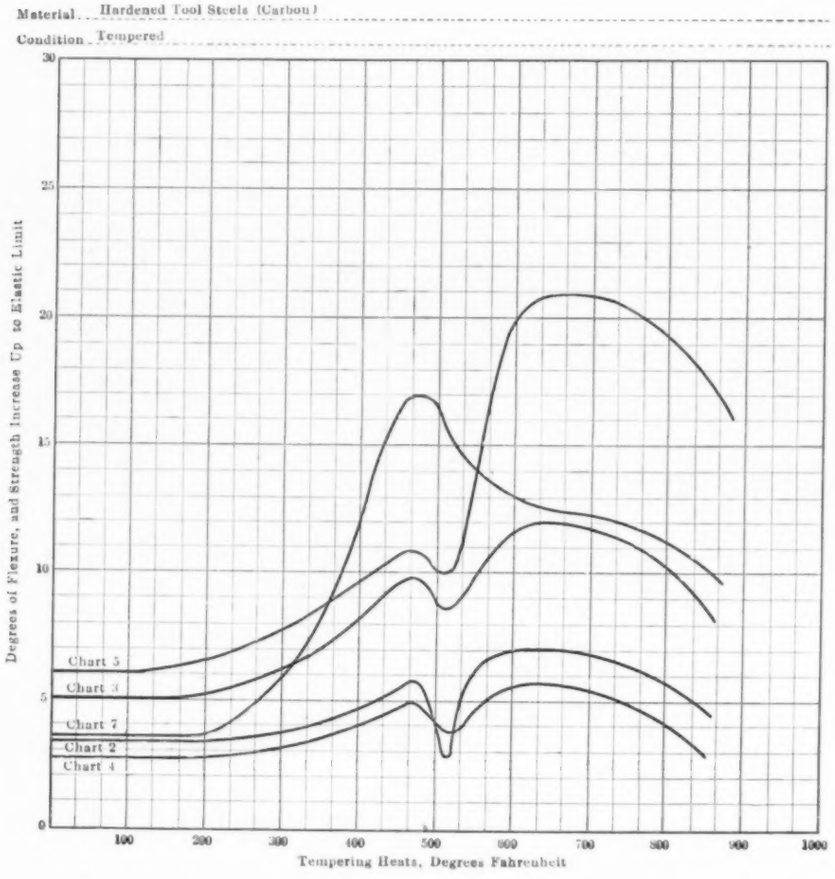


FIG. 8. CHART SHOWING TEMPERING HEATS AND CORRESPONDING CHANGES IN STRENGTH FOR TOOL STEEL

While the special high-carbon steels harden perhaps 5 or 10 per cent. more than the ordinary grades, their strength is actually from 300 to 400 per cent. greater. This increase of strength when properly hardened and tempered, is directly in proportion to their susceptibility to crystallization when overheated, and according to many tests to destruction on different samples, the two properties are inseparable so long as the two specimens compared have had the same advantage of hammering or forging. By the very simple expedient, therefore, of merely sawing off a small piece of tool steel and crystallizing it, as described, then measuring it for drop in hardness, we have established for ordinary shop practice, a ready means whereby tool steels may be analyzed for their available carbon content regardless of what the chemist's analysis may show. This is due to the fact that unavoidable conditions enter, which sway the chemist's work, and necessarily his findings; while on the other hand, the test is purely dynamic and it recognizes nothing in the chemical constitution of a metal except its dynamic or mechanical properties. Hardness as one of the capital properties of all tool steels is, of course, measured directly, while the strength, inseparably linked with carbon content, is expressed by the measured drop in hardness after quenching at a light yellow heat.

The question has been asked repeatedly: How about the carbon content in alloy steels? As a matter of fact, alloy steels usually have a very low-carbon content, often so low that it is possible to judge by the progressive hardening power after quenching. Confining ourselves, however, to alloy tool steels, experiments show that while some of the alloyed elements may exert nullifying influences, the fact remains that when carbon is to be the backbone in the steel, its greater or less percentage is easily detected by the scleroscope the same as in ordinary steel. Chromium, if as high as 3 per cent. in steel, retards the effect for the reason that a higher heat is required to harden, although slight quantities have very little effect. This also is true in some of the intra-high-speed steels containing some tungsten, etc.; these harden at a higher heat, but show a strong tendency to crystallize, by overheating them.

Treatment of Very Fine Steel

Tool steels of very high carbon are called special steel, and are not, as a rule, found on the open market, and for this there are several reasons.

In the first place, unless this steel is treated with the greatest care, it will very easily crystallize and become brittle and of little value. This abuse of one of the greatest treasures that metallurgy has to offer to metal workers, etc., has thus been so generally mistreated that a cry has been raised that it is an extremely brittle steel, and everyone seems to regularly recognize it as such. The truth in the matter is, however, quite to the contrary, provided, of course, the steel is treated right. Steelmakers know this to be a fact, but since there have been no instruments in the past which could guide toolmakers in the treatment and the production of fine, very hard and strong tools, naturally a standard had to be adopted calling for low-carbon steel.

English steels thus run from 0.90 to

1.10 carbon, while American steel runs on a higher average, and often up to 1.35 carbon, and even this latter steel is commonly abused. Another common fear for the use of high-carbon steel is the warping and cracking. This is perhaps a theory based on the assumption that it is very brittle, rather than that it is a matter of fact. The interesting question was taken up in order to satisfy numerous inquiries, just how much more does a 1.65 carbon-steel warp in hardening as compared to one averaging about 1 carbon.

As it was, we had for more than a year hardened many thin pieces or strips of 1.65 carbon steel for test specimens together with all kinds of other steels, comprising lower carbon and also alloy steels. With this experience we always found that the high-carbon pieces warped least, if at all, especially when we used special care in hardening. This care in hardening consisted simply of heating slowly, uniformly and just enough to give the full hardness. By taking similar care in the other steels there was always some and often very much warping. By overheating high- and low-carbon steels as a great many tests showed, two strange conditions exist, viz., the former loses hardness through crystallization, but does not warp nor crack, while the latter does not lose hardness except a trifle, but usually warps and cracks.

In drawing the temper the high-carbon steel often gets harder and at the same time stronger when crystallized, while the low-carbon steel gets softer and a little stronger also. In either of these cases the steel is rendered unfit for tools, although it is obvious that so long as the piece has not cracked or distorted we have a chance to reclaim by annealing, to decrystallize, and reharden with the proper heat, and when the tool will be nearly as good as ever. Another strange fact which develops in overheating high- and low-carbon steel is that the former never decarbonizes at the surface, while the latter does, as when heating to 1800 degrees Fahrenheit for carbon content tests with the sclerscope. The question has often arisen as to why high-carbon steel warps less according to our trials, of it, and its regular use of it in our line of manufacture, while others often claim reverse results. My opinion always has been that warping and much cracking of in hardening is due to the use of excessive heat and which by generating steam, causes unequal hardening, i.e., some parts are chilled, while others are still red hot. While high-carbon steel actually warps less if properly treated than lower steel, some alloyed, it has in its favor the property of hardening at a low heat, which necessarily allows the water to take to it and chill it at once and uniformly.

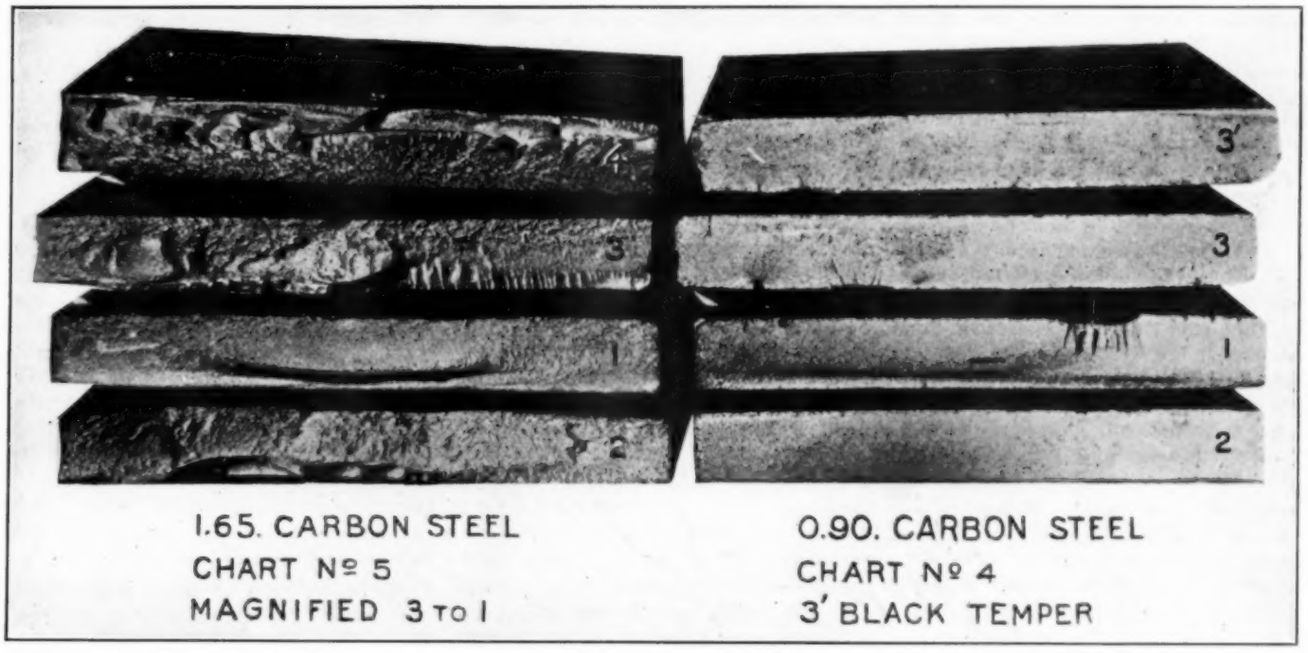


FIG. 9. GRAIN OF BROKEN PIECES OF 1.65 AND 0.90 CARBON TOOL STEEL

How to Temper Fine Steel

Having thus, by careful research, arrived at a conclusion that to temper a steel properly for strength and the maximum hardness, we must know the composition beforehand; we are now in a position to select a good steel. Such a steel would to the chemist analyze to 1.65 carbon, low in phosphorus and low in manganese. Handed to the up-to-date shop foreman, he would find that when he heats up a test piece to a bright yellow and quenches it, his scleroscope indicates a hardness of less than 0.70. This proves to him that all of the 1.65 carbon in the steel is available, and he next hardens a piece at a low heat to test, for hardening power. If now he finds a hardness exceeding 105 he knows that the manganese is low enough, the hardness is high enough, and he is ready to proceed in his work of cutting up the steel for the various tools required.

When the tools have been prepared for hardening, any suitable means of heating may be employed provided the heating is slow and uniform and constantly under a watchful eye, to prevent possible overheating. This steel hardens so easily that large punches or dies having complex configurations, may be placed flat on the water so that the cutting side will harden first and will, therefore, hold their original shape. When thus the surface has been hardened the whole piece may be slowly lowered and hardened all through. This is seldom possible in low-carbon steels usually recommended for dies. When the tool has thus been hardened, its hardness should be measured in order that the exact tempering strength may be known, so that the tempering may be accordingly, or so that we may know just what to expect of the finished high-duty tool. A punch or die thus showing a hardness of from 105 to 110 will develop enormous strength and will stand an increditable amount of punishment, when properly tempered. And with a standard grade of steel thus at hand, we are able to prescribe a hardness number which is significant and reliable.

Suppose it is desired to stamp out pieces from unannealed tool steel sheet or flats, running from 40 to 50 hard and which is very severe indeed on the tools owing to the want of hardness to hold an edge. We will then draw the temper to a light gold or 470 degrees Fahrenheit leaving a hardness of about 102. The reason why

just this temper is prescribed is a scientific one, that is, we have reheated the tool to a point where the greatest hardness consistent with great strength is reached. Many mechanics will prefer to draw the temper a little more or to a brown, to make sure, that there will be less brittleness, but this is now proven to be a grave mistake. By tempering to a brown (about 510 degrees Fahrenheit) 3 or 4 degrees of hardness are lost, and the steel gets weak and brittle again. This peculiar brittleness continues until a purple is reached (530 degrees Fahrenheit) and when 3 or 4 more degrees of hardness are sacrificed, with indeed little gain in strength.

These facts show that if a tool is too brittle at a good straw yellow, we have nothing to gain until almost a blue is reached and this at a loss of 10 per cent. in the original hardness. Tools, therefore, which are required to resist enormous shocks and strains as in cold pressed work may gain double the strength available at the dark straw temper if reheated to about 600 degrees Fahrenheit or a good blue. The loss of hardness then would be about 18 degrees. These rules only apply exactly to carbon steel, having the content of about 1.65 or showing a crystalized hardness of from 65 to 70 by the scleroscope. Steel higher in carbon as indicated by greater losses in the crystallization test, while exceedingly strong, does not gain much by tempering to a blue and is brittle. Steels lower in carbon than 1.65 are comparatively very weak and gain little in strength by tempering to a blue.

[In the course of this most valuable article Mr. Shore mentions, but does not elaborate, a novel method of determining the carbon content of tool steel by mechanical means. A future article by Mr. Shore will describe this in detail.—Ed.]

Safety Devices in Machine Shops and Manufacturing Establishments*

By John E. Sweet

Devising safety devices and the enactment of laws compelling employers to install them, does not seem to accomplish all that is hoped for. The persistence of the workmen themselves in devising ways to render the devices abortive is about enough to dishearten every hope we may have of remedying this horrible waste of life and limb and the resulting misery.

Within the last few months three cases have come to my attention where disobeying instructions led to the loss of two or three fingers. A boy was set to work on a punch press and given a rod of iron to remove the pieces, and such instruction how to work the press that he ran it successfully; when he discarded the poker, did not remove his foot from the pedal, put in his hand and punched off his fingers. The jury's award was some hundreds of dollars, and this jury's award is another discouraging feature.

If the proprietor is forced by law to apply all available safety devices, and the workman uses or fails to use them, and gets killed or injured, goes to law, and the jury gives him an award, "what's the use?" the proprietor will say.

The two other cases that have come to my attention were the admirably devised shield over the revolving knives of wood-planing machines. One was locked back by a simple clamp, and always kept locked back; and the other was hung up on the wall.

We all know, or think we know, that if the proprietor of a factory has provided all available devices for safety, and the man neglects to use them and gets killed or injured, the proprietor should be absolved from all blame; but will the courts and juries look at it in that light?

How easy it will be for the victim to prove that the proprietor knew he was not using the device, and that it was not himself that put it out of use; then what? I know this is a negative argument, but should it not be taken into consideration? I can hardly be looked upon as disinterested, or as taking the manufacturers' view, though I now hold the position of employer. I have myself devised safety appliances and put in use those made by others.

I have paid large sums to employees for injuries for which they were entirely at fault. We have had two men killed and one seriously injured by being wound around shafts, in spite of the fact that the rule known to all was that no belt was to be put on without stopping the shaft; and what I am discouraged about is not from fancy theory, but from the facts of experience.

Perhaps the only remedy for the negligence or carelessness of the workmen would be a law fixing punishment for interfering with safety devices, rendering them inoperative, except in cases of necessity; for there can be no safety device but that for one cause or another has to be removed or put out of use occasionally.

This leaves a loophole; so the law, if one is proposed, must be carefully drawn, and may require more ingenuity than the invention of the safety devices themselves. There are certain kinds of accidents that no number of ingenious devices can prevent.

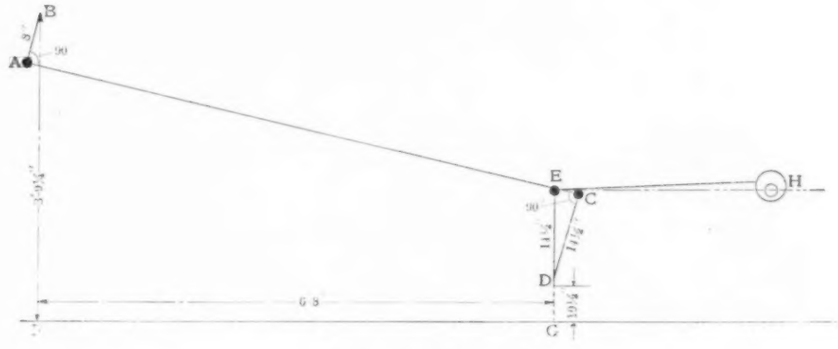
If a workman using a circular saw pushes the board with his thumb and forgets to take his thumb off before it reaches the saw, or if, in planing, he follows up the board with his hand on the table, and so with all devices, there is a way for the careless workman to beat the device out.

*Read at the first convention of the American Anti-Accident Association, held in New York City, Feb. 11, 1909.

A Problem in Levers

By Renton Hind

I submit a problem to the readers of the American Machinist. Referring to the skeleton sketch, lever AB operates the valve of a vacuum pump getting its motion from rocker arm CD; CD is keyed to the same shaft as is the rocker arm DE, which derives its motion from an eccentric at H.



A PROBLEM IN LEVERS

With the eccentric in central position, DE is vertical, while angles ACD and CAB are right angles. This is obviously arranged so as to give the valve equal travel to the right and left of its central position. For reasons wholly without the problem it was decided to move D 8 inches nearer F and the question at once arose as to what changes would be necessary in the angle CDE and ABF, and in the length of the rod AC to maintain the conditions above noted.

The problem resolves itself into this: What is the angle CDE in the figure and what is the length of the rod AC?, for when these values are found the same method can be employed in finding the values due to the change and a simple process of subtraction will give the change to be made in angle CDE and in the length of the rod AC. My results for angle CDE and AC, as shown in the figure are 8 degrees 41 minutes and 7 minutes 3/8 seconds.

A Proposed Mammoth Testing Machine

Introduction into the United States Senate of a Bill for the Construction at Government Expense of a Testing Machine of Great Size and Power

FROM GOVERNMENT DOCUMENTS

Under date of January 28 Senator Teller introduced into the United States Senate a bill for the purchase of an Emery testing machine of magnificent proportions and as these are well set forth in the bill as introduced we give a copy of parts of it as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the secretary of be, and hereby is, authorized to contract with A. H. Emery, of Stamford, Conn., without advertising, for the construction and erection of a large testing machine of his design, from specifications to be furnished by him.

This machine shall be equal to or superior in accuracy, ease of working, and durability to the celebrated Watertown Arsenal machine which was invented, designed and built by him.

It shall be built according to the designs which have already been prepared by him after consultation with the largest bridge builders of the country as to the size of the bridge members and other work to be tested by it, which design has been shown to several of the best engineers of the country for criticism and approval by them.

It shall be able to give and weigh loads of tension up to 5,000,000 kilograms, or 11,000,000 pounds, and loads of compression up to 10,000,000 kilograms, or 22,000,000 pounds, on specimens up to 100 feet or more in length. The main loading platforms for testing bridge-compression members, columns, and so forth, shall be not less than 8 feet wide and 12 feet long, and shall be adapted to receive auxiliary holders and platforms.

The machine shall be provided with tension holders, to seize and test to destruction round, square and rectangular bars, with loads up to 1,500,000 kilograms, or 3,300,000 pounds, with lengths up to 100 feet or more.

It shall be provided with a pair of holders, together with their pins and bushings, as designed by him, for testing bridge links up to 100 feet or more in length, with all loads up to 5,000,000 kilograms, or 11,000,000 pounds.

It shall be provided with an auxiliary pair of compression platforms with hardened faces for testing stone, and so forth, with all loads up to 10,000,000 kilograms, or 22,000,000 pounds.

It shall also be provided with a pair of auxiliary platforms, with pins 24 inches in diameter and 8 feet long, for testing pin-ended columns with loads up to 10,000,000 kilograms, or 22,000,000 pounds.

There shall be furnished with the machine, as a part thereof, for its erection and use, a pair of 80-ton electric cranes and the ways for them to run on.

There shall be furnished with the machine, as a part of the same, the necessary hydraulic pumps and their electric motors for the operation of the presses.

The contract price for this machine, complete with its foundations erected in place, together with its accessories, as above specified, shall be $1,750,000, which sum is hereby appropriated out of any money in the Treasury not otherwise appropriated.

The Need of the Machine

Accompanying the bill Senator Teller submitted a statement which explains the need of the new machine so well that we reprint a portion of it as follows:

The Watertown arsenal testing machine, invented, designed, and built by A. H. Emery under a contract made for it before it was designed, was tested for acceptance in 1879 by the board appointed by President Grant to procure and use a large testing machine to investigate the properties of materials used in structures. This board was appointed at the request of the American Society of Civil Engineers.

In testing this machine for acceptance, a large link was broken with about 60 per cent. of the load the maker had said it would certainly stand, and the well-known engineer, A. L. Holley, who was a member of the board, stated that that single test was worth more to the country than the entire cost of the machine, as it showed why so many of our bridges had fallen. Many tests of links were made during the next few months and most of them failed with 50 to 70 per cent. of the load which the makers had guaranteed them to stand. By the use of this machine in making these tests, the builders found out how to make bridge links so that they would stand loads they were guaranteed and expected to stand, and bridges built since that time have not failed because of poor links. In the failure of the Quebec bridge, not a link failed or was hurt until the bridge fell, when, of course, they were distorted and twisted into all sorts of shapes.

Lesson of the Quebec Bridge

The Quebec bridge, which fell in 1907 during its erection, had the longest single span of any cantilever bridge yet built. The fall of this bridge caused the direct loss of many millions of dollars, of several years of work, and of nearly a hundred lives, and an indirect loss of several millions of dollars more during the several years needed to redesign, build, and erect another bridge in place thereof.

The two members which failed and caused this bridge to fall were compression members 57 feet in length and weighed about 120 tons each. They failed by buckling or crumpling up. Had these or similar members been tested in a machine like the one proposed they would certainly have failed, and much stronger columns would have been used and this large loss of time, life, and property might have been avoided.

The question may be asked, Why were they not tested? Members of this size cannot as yet be tested, as there is no good testing machine in the world of even one-tenth the necessary capacity.

This Quebec bridge, while not an American enterprise, was designed and built by an American company, and its fall has given the American bridge builders "a black eye" from which they can only recover by having and using a large testing machine and testing the actual members that enter the bridge construction, or at least similar members. Nothing less than this will reinstate the American bridge builders in the confidence of the public of this country and Europe.

Exacting Requirements

But a machine to make this test is not simply a great hydraulic press which will crush the specimen and give only an approximate idea of the load that crushed it, but it must be an instrument of precision, a machine which can take a member of 50 or 100 or 150 tons weight and test it to destruction, not merely crush it as a big hydraulic press might do, but carefully test it, noting when it begins to take a permanent set under the large loads put upon it; and this machine should show, when properly used, the inward action of this column, this compound member built up of several parts. This machine should show the changing limit of elasticity as the load progresses, what it is at all times and just how the column is enduring the load which is working its destruction, what fatigue the column has at all times during the test, and just what permanent set it has at each stage of the test, so that the operator may know the inwardness of this column while it is being tested and what similar columns should be able to stand.

The Watertown arsenal machine did this kind of work for bridge links, and a

machine should be had which will do this same thing for large bridge columns and compression members. The Watertown arsenal machine is the only large machine in the world built on lines fit for this work, but it is a very small machine compared with what is needed to properly test these large members and show us what they are and what they should be.

This machine, which was put in service thirty years ago, has been in constant use ever since and now has many months of work piled up ahead of it.

During this thirty years the use of testing machines has increased, probably more than a hundredfold, yet no other large testing machine has been built, either here or in Europe, which at all compares with it either in accuracy or general usefulness.

Comparison with the Watertown Arsenal Machine

The Watertown arsenal machine has a capacity for loads of either tension or compression of 800,000 pounds on specimens up to 25 feet long, while the proposed new machine will give and accurately weigh loads of tension up to 11,000,000 pounds and loads of compression up to 22,000,000 pounds, on specimens of any length up to 100 feet.

The arsenal machine was sold before it was designed, when it was expected to weigh about 40 tons, but as finally designed and constructed it actually weighed about 80 tons. The proposed machine with its accessories will weigh about 3500 tons, or more than forty times as much as the arsenal machine. It will be able to test compression specimens with over twenty-five times the section and four times the length or one hundred times the weight that the arsenal machine can, and these tests will be of inestimable value to the engineers and bridge builders of the country.

There are in this country three large testing machines owned by bridge companies for testing bridge links, one of 1,200,000 pounds capacity, one for 2,400,000 pounds, and one for 4,000,000 pounds, but they are far from accurate. The loads are given by hydraulic presses and are not definitely known, as these machines have no scales to weigh the loads nor any accurate means of determining the loads given by the press or the various losses by friction in the press. These machines were designed for testing links, and are not suitable for testing columns.

The failure of the Quebec bridge has greatly disturbed engineers and bridge builders in this country, and emphasizes the great necessity of experimental data on and the actual test of large compression members of bridges and other structures.

The main part of the machine as designed is about 153 feet long, while the concrete foundation is about 200 feet long, 30 feet wide, and 15 feet deep, and the metal work in these foundations about 192 feet long. The width of the machine is about 25 feet, and it will require for its erection and use two cranes of 80 tons capacity each.

The weight of the metal work of this machine, including its accessories, cranes, and the metal work of their ways, will be when finished nearly or quite 3500 net tons, mostly of steel, and a large part of this machine has to be of unusually good workmanship and generally much better and more accurate than has been put in any very large machine of any kind whatever.

Appropriation for Construction

The bill appropriates for the construction and erection of the machine, its foundations, accessories and cranes, exclusive of $200,000 for the building therefor, the large sum of $1,750,000. But is this sum really large when we consider the real quality and value of this machine?

Let us compare it with the cost of a modern battleship, say one of the new ones proposed of 26,000 gross tons. Under ordinary conditions of cost of labor and materials these two battleships may be assumed to cost $12,000,000 each, armed and equipped ready to go into commission, but without any ammunition, coal, or stores, at which time the weight may be taken at about 22,000 gross tons each, which makes the cost a little over 24 cents per pound.

The price of this machine and its accessories, which at first seems large, is about the same per pound as that of the completed battleship. While the study and brains, skill and experience necessary to properly design and build a testing machine of this size and quality is applied to a single one of these large machines, the battleships are partly redesigned year after year and their general construction repeated over and over. Every one of them will, in a few years, have been wrecked, worn out, or become obsolete.

Now, what will be the total cost of one of these large battleships during its short life of, say, twenty years? Should business and prices be normal during their construction, or those of good business times, we may expect them each to cost, completed, $12,000,000, to which we may add a yearly average for ordinary and extraordinary repairs of 5 per cent. of this cost, which for twenty years at this rate will be $12,000,000, or, together with the first cost, $24,000,000, to which we may add at least $1,000,000 per year for men, stores, etc., for each year it is in actual commission or $16,000,000 should it be in commission sixteen years during its supposed life of twenty years. This, added to the $24,000,000, makes $40,000,000 as the life cost for the services of one of these great battleships, or for the two now being authorized, $80,000,000.

While we spend this large sum for these two battleships for their short life of twenty years or less, should we hesitate to spend about 2½ per cent. of this sum for this large machine, its foundations, and the building therefor, which will not be worn-out or obsolete in fifteen or twenty years, but will, in all probability, be an extremely valuable machine for many, many years to come?

The Watertown arsenal machine has been in constant use ever since its construction thirty years ago, continually standing at the head of all the testing machines of the world, and this new machine will, if built in the spirit of its design and properly cared for and used, be a fine machine for generations to come.

Suppose that this machine is built and housed for a sum of $2,000,000 or less, and that we appropriate annually for its use $67,500. This annual expenditure would seem large to some, but it is only one-twentieth part of 1 per cent. of the amount we are asked to spend on the navy for one year, while the knowledge gained by the engineers of the country by its use would be of the greatest possible value.

Wide Range of Usefulness

We are spending more than $1,000,000,000 a year in this country on rails, bridges, locomotives, ships, guns, engines, machinery, buildings, and other structures, all requiring a knowledge of the properties of materials in their design and construction, and if this machine is built and used the engineers will know better how to spend, year after year, these vast sums of money.

The proper use of this machine will teach our engineers how to make bridges and other structures safer and lighter and thus help us to save our metals.

The bill provides for the machine, its foundations and accessories, including its cranes and their ways, $1,750,000, and for a building therefor, $200,000, or so much thereof as may be necessary; this latter sum to be immediately available, as it should be, so that the building can be put under construction and erected very promptly this year, as the machine will certainly be delayed in its construction unless the foundations for it can be put in this coming summer so as to thoroughly set before putting the metal work of the foundations therein.

The proper design for this building can only be made after it is known where it is to be placed, and not until then can its cost be determined. In one place $100,000 might do, while to put a suitable fireproof building in another place might cost $200,000. It should be not less than 76 feet wide and 240 or 250 feet long, and should be in keeping in its decorations and looks with its surroundings and with the machine.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Mirror as a Time Saver and a Magnetic Work Holder

A few days ago while in the grinding department I noticed one of the men watching a piece of old looking-glass which he had got propped up alongside his machine table, and which in its improved form has proved a timesaver.

Fig. 1 shows the arrangement in working order. *A* is a mirror held in position, about 2 inches back from the face of the emery wheel and inclined a few degrees from the perpendicular, the bottom edge of the glass being about 2 inches below the level of the machine table *B*. It is fixed to a piece of flat, mild steel fastened to the machine frame, as shown at *C*, and bent so as to clear the emery wheel.

D is a magnetic work holder (shown more clearly in Fig. 2) and consists of a brass casting having four 1-inch holes

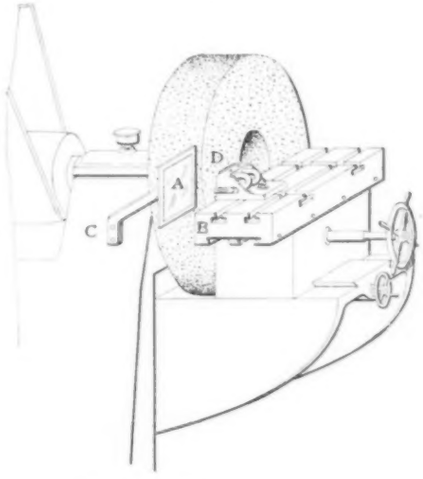


FIG. 1. THE MIRROR IN USE

into which are inserted two hardened-steel permanent magnets *E*. These are ground off level with the face *F* (which is machined) and forms a flat face for the work to rest against. The magnets are held in place by four brass screws *G* (two of which only are shown), the other two being inserted from the under side.

H J K are mild-steel thrust plates; these prevent the work from falling down, or moving sideways when in contact with the emery wheel. The magnetic holder is provided with a loose tongue on the under side for positioning it square on the grinder table, the tongue, of course, being removed when it is required to use the holder on the ordinary disk grinder when the faces *L* form the necessary squaring stops.

To operate, the work is placed on the face of the magnetic holder and fed across the face of the emery wheel; it is then brought opposite the mirror *A*; the operator without changing his position from the hand wheels can see at a glance by the reflection in the mirror, whether or

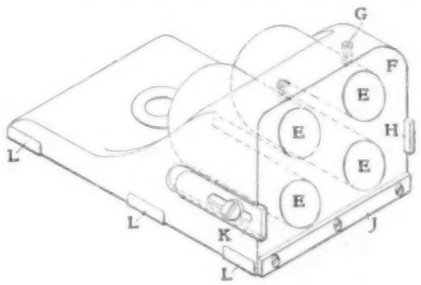


FIG. 2. THE MAGNETIC WORK HOLDER

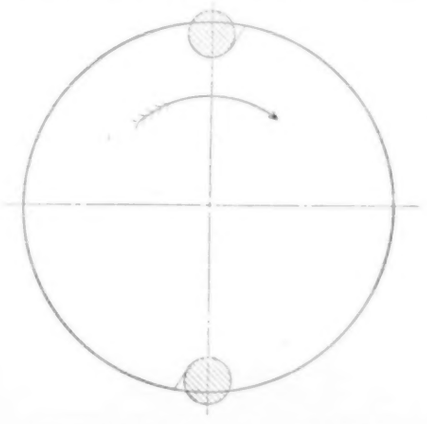
not the work is done. Steel stampings, castings, and drop forgings are treated in this manner, and in most cases, since the mirror has been adopted, a saving of 50 per cent. in time taken has resulted.

Birmingham, England. THRUMY.

Cutting Rack Teeth in the Lathe

Having a quantity of rack teeth to cut in ¼-inch round bessemer rods, there being no milling machine or rack cutter in the shop, the following method of turning out the job was adopted, and was found efficient and rapid.

A piece of 2-inch shafting was centered and turned, and two grooves planed in opposite sides, as shown in the sketch, and of sufficient depth to allow the stock to project the full depth of the tooth required. This was placed between centers in the lathe. A tool was then shaped to fit the tooth spaces. The ¼-inch rods



CUTTING RACK TEETH IN THE LATHE

were then placed in the grooves, and held in position at one end by the lathe dog, and at the other by a collar. The operator then proceeded as in cutting an ordinary thread. The trifling angle at which the teeth were cut was not noticeable, the width being less than 3/16 inch.

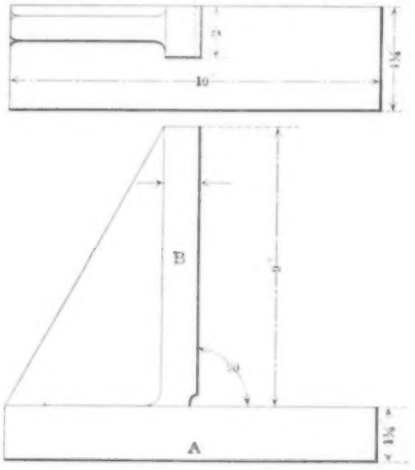
When the quantity required would warrant, as many grooves could be cut as the circumference of the shaft would admit. This method could be modified to cut teeth in small square stock, by milling square grooves spirally in the shaft, at an angle that will bring the teeth square with the sides of the rod.

FREDERICK LEU.

Long Island City, N. Y.

Setting a Planing Vise Square

Setting a shaper or planer vise so that the solid jaw face is parallel with the



SETTING A PLANER VISE SQUARE

ram or the ways of a planer is a very quick operation; by using an indicator in the tool post and moving the ram back and forth the vise may be adjusted perfectly parallel. But in setting the solid jaw face of the vise at 90 degrees with the ram, there is more to contend with. A great many draw out the ram and square from that, but as a rule the front end of the ram is worn taper more or less, thus a correct reading cannot be gotten for an accurate job, neither can the graduations on the vise be relied upon.

The cast-iron master square shown will be found to be a very convenient tool to have on a planer job. The base *A* may readily be clamped against the face of the solid vise jaws; this gives the face

B on which to use the indicator. By this method a great deal of the error in the shaper due to the wear in center of the cross rail may be overcome by clamping the master in the vise so that the face *B* will come in about the same position as where the cut will be taken.

The table can also be lowered and clamped where the work will require it before setting the vise, thus doing away with any chance for an error in lowering the table after the vise has been set. The same tool will be found just as convenient in setting an angle plate at 90 degrees on a shaper or planer.

Stamford, Conn. C. H. M

A Cylinder Planing Fixture

In the accompanying line cut I have attempted to show a fixture used in planing a certain design of gas-engine cylinder.

By reference to Fig. 2, one will observe that there are three surfaces *A*, *B* and *C* to be planed. Each of these surfaces is at a different angle; they must be in exact relation to one another, true with the bore, and a given distance from the center. Before we adopted the fixtures here illustrated, we had a good deal of trouble in getting the cylinders planed uniformly, and near correct enough to be interchangeable. All planing is done in one chucking, and in relation to the same points of the bore. This is done by the cones upon which the cylinder is held turning in the angle brackets, instead of the cylinder being turned on the cones as is customary. By reference to Fig. 1, it will be seen that the cylinder and the two cones are securely bound together by the rod through the center, but free to revolve in the angle brackets. For each planing position of the cylinder there is an angle iron such as is shown at *D* in Fig. 2 to throw the cylinder to the correct angle. This brings all the surfaces in turn parallel with the planer table, and obviates angular feeding.

In the top of the head angle bracket there is a tool-steel plate *E* set in, in which by means of a dovetail are held hardened steel templets for setting the cuts by. For each operation there is a templet which gives the operator his widths and depths without the necessity of measurements.

Grantham, Eng. J. F. M.

A Cutter Relieving Kink

A little scheme for "backing off" or relieving small forming cutters such as cutters for small gear and pinion teeth, came to my notice the other day and it is so original a method and also so successful that I herewith present it to your readers.

FIG. 1

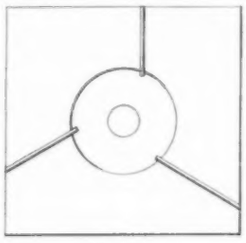


FIG. 2

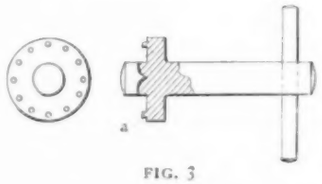


FIG. 3

RELIEVING A FORMED CUTTER

First the cutters were made as per Fig. 1, being formed, and sawed, the number of saw slots in this case being 12. A square cast-iron or soft-steel block was then recessed a little larger in diameter than the cutter and the same depth as the thickness of the cutter. Set into this block were 3 pieces of hardened steel projecting into the recess as shown in Fig. 2. Then a wrench was made to fit the hole in the cutter and also a series of small projections were milled on the wrench as at *A*, Fig. 3, to fit the saw slots in the cutter.

To perform the operation of relieving the cutter blank the cutter (which was soft) was put into the recess in the block with the three projections fitting in three of the saw slots. The wrench was then placed in position (the block being held in a vise) and given a slight turn which bent the teeth backward a trifle, the amount turned being marked on the block.

The cutter was then indexed on the three projections and the same turn on the wrench given again. This was done until all of the teeth had the required "relief," or bend (which throws the cutting point out).

The cutters which were handled in this manner were entirely satisfactory and gave good service.

South Bend, Ind. ARTEBE.

Helps in Cutting Threads

I have found the following simple device useful, and it is new so far as I know. In cutting the general run of threads, when the pitch is not a multiple of the lead screw, it is customary to draw the lathe carriage back to a fixed point (usually the tailstock) at the end of each cut. The correct relative positions of the spindle and lead screw are noted by a chalk mark on each, or on the driver and driven gear wheels, and by bringing these into coincidence each time the clutch engages without danger of a second start. This often involves stopping the lathe, after each cut, as the marks on the gear wheels are not visible from the front of the lathe, and the lead screw is too small in diameter for the position of a mark on its surface to be recognized accurately while it is in motion.

The semaphores shown in Figs. 1 and 2 were designed for the benefit of our youthful lathe hands, and prevented them spoiling work from the above causes. The arms are screwed to the outside of the initial-driven and final-driven gear wheels by the screws which fasten the wheels to their respective spindles and set in the position shown in Fig. 2. They revolve with the wheels, are visible from the tool box, and as they revolve in a fairly large circle, it is easy to recognize their relative positions and drop the clutch in without stopping the lathe; a consideration in cutting screws piece work.

They should be made as large as possible so as to stand beyond the circumference of a large wheel. They are made of sheet metal with a boss or loose washer to prevent them from fouling the screws which secure the other wheels in the train.

Birmingham, England. C. C. WALTON.

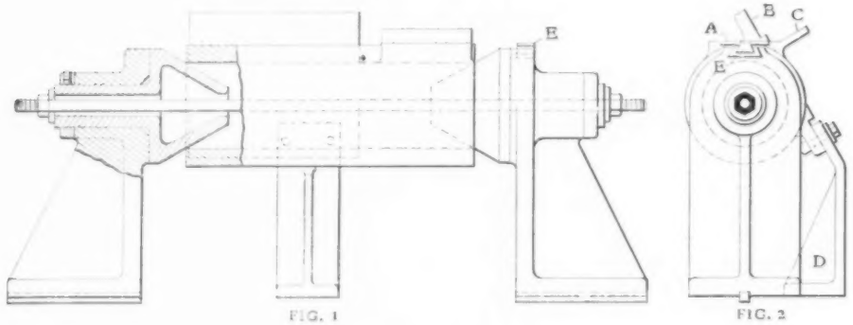


FIG. 1 FIG. 2

A CYLINDER PLANING FIXTURE

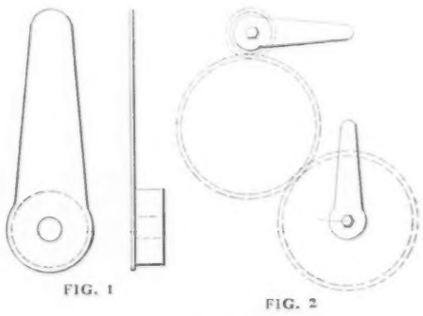


FIG. 1 FIG. 2

HELPS IN CUTTING THREADS

Kinks for Draftsmen

Those who have been using the Brown & Sharpe protractor have not done so without finding it rather difficult to bring the inside part to the exact angle wanted.

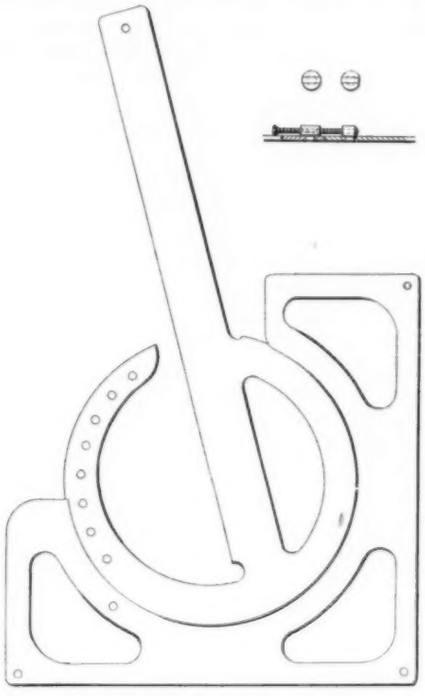


FIG. 1. A SETTING DEVICE FOR A B. & S. DRAFTSMAN'S PROTRACTOR

There is considerable friction in the groove, and the only way to adjust the protractor to the needed position is to kick slightly with a pencil on the end of the bar.

To remedy this, I devised the arrangement shown in Fig. 1. A row of holes, about ⅛ inch in diameter is drilled every half-inch on the moving part, and one hole of the same size is drilled in the holder. Those holes are reamed smooth to ⅛ inch, so that all will be of the same diameter. Two plugs are turned to a nice fit in these holes; one of them is tapped for a 6-32 screw, while the other is drilled so that the screw will go loosely through it. A head is made on one end of the screw, or the end of the piano wire used for the screw may be simply bent; when the two plugs are in place a small copper head is riveted on. The hole in the guide of the protractor ought to be drilled in front of one of the large holes, so that the screw will be easy of access. When the division wanted is almost in line with the o of the scale, the plugs are put in place and the screw brings the instrument easily to position. The screw may then be taken off so as not to interfere with further use of the protractor. The whole operation does not take more time than opening or closing a bowspring compass.

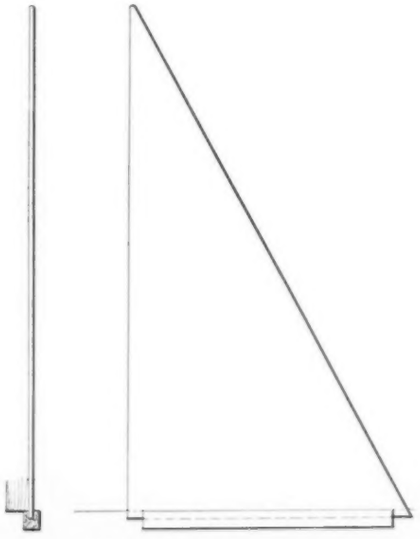


FIG. 2. A TRIANGLE GUIDE

Fig. 2 shows a guide very useful for working on sketch pads. It is only a strip of hard wood with a saw slot fitting an ordinary triangle. That guide is put on or taken off at an instant notice, and I found it a great help for making decent looking sketches in a very short time.

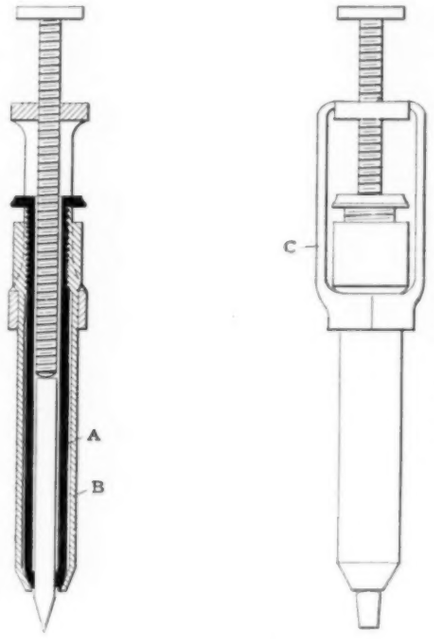


FIG. 3. A LEAD HOLDER FOR COMPASSES

Fig. 3 shows the changes made in the lead holder for compasses so as to prevent the lead from backing under pressure, when you use a lead harder than 3H; also to give an easy way to feed it without loosening the holder. The holder parts as existing are *A* and *B*. On *B* is soldered a yoke *C* made of 1/32 inch copper strip, through which passes a screw. The holder is regulated so that the lead will move in and out, but not easily. When the lead is too short for the screw to push it further (for the screw ought not to interfere with the pressure screw of the leg of the compass) a small piece of wire between it and the screw will cure the difficulty.

Lynn, Mass. P. FENAUX.

Tooth Angles for Milling Cutters

The accompanying table may be of service to toolmakers and others working on milling cutters. The table gives the center angle for different numbers of teeth, the angle *B* between the teeth, and angle *A* for the sloping side of the tooth flank.

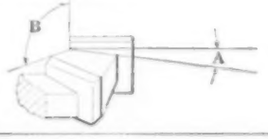
S. C. CARPENTER.

Plainville, Conn.

Angle "A" on Milling Cutters.

No. Teeth	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
Cen. Angle	60	45	36	30	25 43	22 30	20	18	16 22	15	13 51	12 51	12	11 15	10 35

Angle "B" between Teeth	No. of Teeth in Cutter														
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
80	55	40	31	25	22	19	17	15	14	12	12	11	10	9	9
75	50½	35	27	22	19	16	14	13	12	11	10	9	8	8	7
70	45	30	23	18	16	13	12	11	10	9	8	7½	7	7	6
65	39	25	19	15	13	11	10	9	8	7	7	6	6	5	5
70	32	20	15	12	10	9	8	7	6	6	5	5	4	4	4
75	25	15	11	9	7	6	6	5	4½	4	4	3½	3	3	3
80	17	10	7	6	5	4	4	3	3	3	2½	2	2	2	2
85	9	5	4	3	2	2	2	2	1	1	1	1	1	1	1



Formula.
Tan. ∠ A = Tan. Center Angle x Cotan. ∠ B.

ANGLES FOR MILLING CUTTER TEETH

Tapping Holes in Two Parallel Plates

We had to join plates *p* and *q*, Fig. 1, by bolts *f*, the threads *s* and *t* having the same lead. The material of plate *q* was copper, and that of *p* was steel. Threads *s* and *t* had to be in the same line.

At the first attempt we used a long tap, and we tried to tap plates *s* and *t* in one operation. The result was not quite satisfactory. We found out, after some investigation, that the long tap was not accurate. We made several tests and found that the thread changed in the hardening.

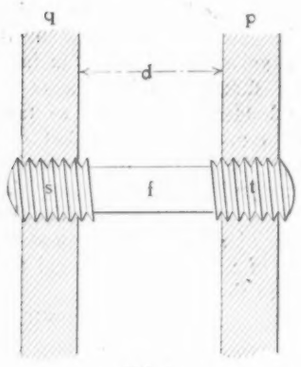


FIG. 1

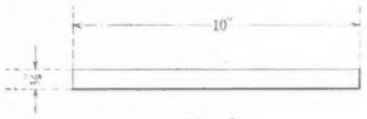


FIG. 3

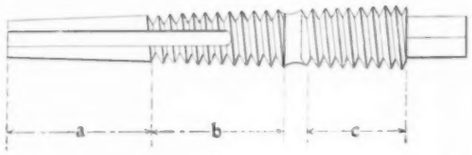


FIG. 4

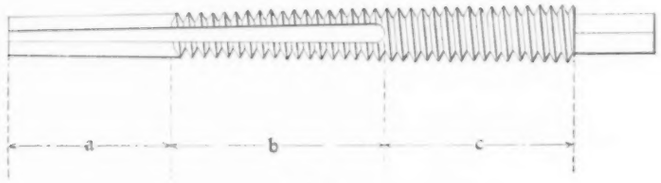


FIG. 2

TAPPING TWO PARALLEL PLATES

Fig. 2 shows the tap used, *a* being the leading and reaming part; *b* the cutting part, and *c* a full thread used as a guide in plate *p*, while the thread was cut in *q*. Desiring to get an easy cut, we made the tapping portion of the tool with a long taper and got very thin chips. The tap worked nicely in the first plate *p*, but when it started to cut the second plate *q* it required considerably more power and the threads *t* and *s* didn't match up as evenly as we wished. We had difficulty when we undertook to screw in the bolts. The fault was in the long tap which changed during the hardening process. We made a number of bars, Fig. 3, of the same dimensions, and found that we could never be sure about the changing of the steel; it was sometimes longer, sometimes shorter.

Having found that we could not depend upon the steel in hardening, a new tap was made as follows: Part *b*, Fig. 4, was made shorter than the distance *d* in Fig. 1; *a-b* was hardened, but *c* was left soft. As *b* was short the error due to changing of the material was reduced to a minimum. The guide part *c* was cut after the hardening of *a* and *b*. Between *b* and *c* we left a small groove. With this style of tap the results were fairly good.

Rochester, N. Y. E. MEITNER.

Allowances for Machine Fits

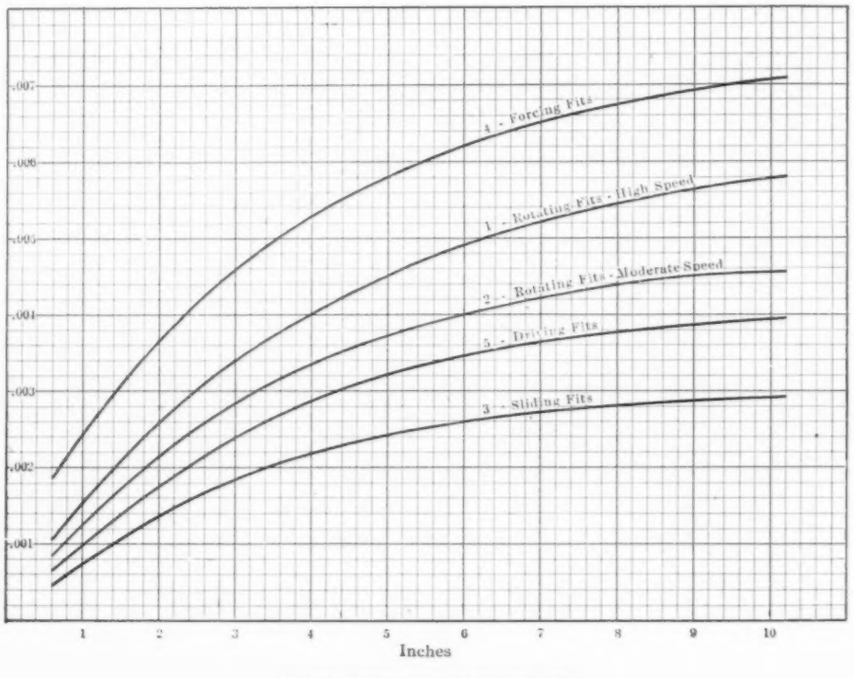
The question of the proper allowance to be made in connection with certain machine fits, is one which constantly presents itself to the designer, and it is with the intent of furnishing a convenient means of determining these allowances, for the cases ordinarily met with in machine design, that the accompanying curves are offered. These curves give the allowance in thousandths of an inch, for sizes ranging from one to ten inches.

The nature of the allowance, whether a clearance or otherwise, will be determined by the relation that the parts fitted are to bear to each other, while the amount of allowance will be determined, partly by this relation, and partly by the size of the pieces fitted.

Curves 1 and 2 cover the most common case with which the designer has to deal; viz., that of rotating fits, where one piece turns in another, as for example, a shaft in its bearing. The allowance for high rotative speeds is shown by curve 1, and will be found to be greater than that for slow or moderate speeds, as given by curve 2, for the reason that usually a larger oil supply is required by the rotating parts, necessitating a larger clearance, than where the rotative speed is slow. The allowance in these cases is minus, that is, the rotating member is smaller than the part in which it turns, by an amount equal to the allowance.

Curve 3 determines the allowance for sliding fits, most commonly met with in cross-heads, etc., and in cases where the surface movement between the two members is very slow, compared to what it is in the case given above. Here also the allowance is minus.

From curves 4 and 5 we get the allowance for forcing and driving fits respectively, where one member fits around another, and no motion is to be allowed between the two. In the case of forcing fits, or press fits as they are also called, the two parts are forced together, one into the other by pressure, usually hy-



ALLOWANCES FOR MACHINE FITS

draulic. The driving fit is used in cases where it is not necessary that the relation between the two parts be so close or rigid as to require a forcing or permanent fit. In these two cases the allowance is plus, that is, the entering member is made larger than the part it enters by an amount equal to the allowance.

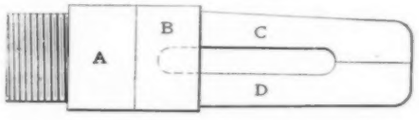
In the majority of cases, where one member turns within another, or is forced into another, the allowance is made on the part that can be finished on the outside, rather than on the part it enters, as it is easier to finish the bore to exact dimensions, and make the part going into it large or small by an amount equal to the allowance, than otherwise.

Westfield, N. J. A. M. BENNETT.

A Screw Machine Feed Chuck Kink

I recently had charge of some automatic screw machines which were worked exclusively upon brass bars, and owing to various causes not altogether within my power to eliminate, had considerable trouble with the feed chucks that would not feed.

A careful investigation disclosed the fact that the feed chucks were in a comparatively good condition except for a very slight fracture, usually at the base of the slot and so small as to escape detection at once. All these chucks had been received in fine shape from the factory,



REPAIRING A FEED CHUCK FOR THE SCREW MACHINE

but had on several occasions been squeezed in the vise and had finally come to such a condition that a practical remedy was resorted to, which put them in a dependable condition again.

Oftentimes after a feed chuck has been drawn, the lips compressed and the piece rehardened the strain on the parts when a bar is entered is too great and it cracks at the place mentioned. Sometimes a careless operator may have neglected to remove the bur or true the ends of a sheared bar and attempting to enter it may have caused some of the trouble.

The feed chuck, shown at *A*, takes 21/32-inch round stock. *B* is a brass collar 5/8 inch wide, turned to the same diameter as *A*, bored taper (in this case 0.005), and of the proper size to insure a snug drive fit over *C* and *D*. It is driven up into close contact with *A*, thus reinforcing the fractured lip and transferring the strain when in use to a point further forward.

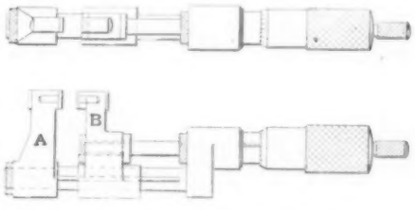
A chuck doctored in this manner has been in constant use for several weeks, and, having been examined at intervals, has shown no enlargement of the fracture, does its work in fine style and looks as though it might last indefinitely.

Lansing, Mich. B. BUBB.

An Inside and Outside Micrometer

Some time ago I designed the micrometer shown. It consists of a fixed jaw *A* and a sliding jaw *B* moved by the micrometer screw. In the instrument shown, the combined length of the measuring faces is exactly 1 inch, so that the instrument can be used for external measurements from 0 to 1 inch and for internal measurements from 1 to 2 inches, and it reads direct in both cases.

Another advantage is that the direction



INSIDE AND OUTSIDE MICROMETER

of rotation of the thimble when opening or closing the instrument is the same as in the case of the regular outside micrometer. I had one of these instruments made, using a standard micrometer head, and it works very satisfactorily.

Pittsburg, Penn. W. ALTON.

A Remarkable Case of Seizing

I send you herewith a rather interesting example of what may happen in thrust bearings. The two pieces are taken from the mechanism of a Morse elevator forming the thrust bearing which takes the thrust from the worm shaft. As you will note, they have welded themselves together as perfectly as though it were done by the best blacksmith. When this bearing was taken down the workman attempted to separate the two disks, but as you will note, broke one in pieces in his attempt. The remarkable part is that neither piece shows any sign of excessive heating. The weld was apparently made cold.

THE SEIZED THRUST DISKS

Have you had samples similar to this from other quarters?

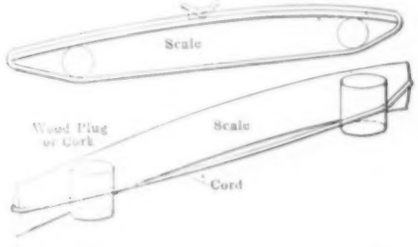
Bridgeport, Conn. T. H. MACDONALD.

[This is about the best example of seizing we have seen. The chisel marks show that considerable force was used.—ED.]

Using a Draftsman's Scale for a Curve

The following method of drawing in curves of large radii, such as large pulley faces, segments of boiler shells, etc., is one which I have found to be simple and efficacious. Using an ordinary drawing scale of oval or flat section make a loop of cord to tie around the scale lengthwise. On one side between the scale and the loop insert a couple of corks, or wooden plugs, and slide them toward the ends of the scale until the scale has attained the radius desired. This is best set to three points; say, one in the middle and one at either end of the curve.

The curve required on such jobs is often set out with a given drop at each side of the center. The sketches show the idea.



A SCALE ARRANGED TO USE AS CURVE

The scale is then placed on the drawing, edge down and the curve drawn from it in the same way as when using a straightedge, excepting, of course, that the pencil is guided by the flat of the scale instead of the edge.

Coventry, England. B. W.

A Homemade Babbitt File

Take a piece of 1/2-inch cold-rolled steel about 16 inches long, cut 14 inches of good, sharp thread and you have a babbitt file that is far ahead of the ordinary file. I have used one of these for the past three months and find it more satisfactory, as it does not fill up and is by far the cheapest.

Janesville, Wis. J. A. R.

[We would think a "buttress" thread would be an improvement.—ED.]

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Terminal Pressures in Hydraulic Accumulators

On page 934, Volume 31, Part 2, of the AMERICAN MACHINIST, W. E. Morey makes a comparison between two accumulators, one with a plunger 100 square inches in area, loaded with 200,000 pounds, falling 10 inches, and the other plunger 10 square inches in area weighted to 20,000 pounds and falling 100 inches, the work done being the same in each case. Then assuming that the first is brought to rest in 1/10 inch and the smaller one in 1 inch, he calculates a terminal pressure of 200,000 pounds in the cylinders and then remarks that "it is evident that the enormous pressure would destroy the piping system if relief valves were not provided.

This is a case in which the law of falling bodies can scarcely be held to apply unless with considerable modification, since the fall of the plungers is retarded from the instant they begin to drop until they are brought to rest. This retardation is usually such a variable quantity that it cannot be calculated, but the effect of it is so pronounced that an accumulator plunger may often be observed to fall a distance of 10 feet, and being stopped in the ordinary way by the closing of a valve on the line, produce no more effect than is often done with a drop of 10 inches. In fact it is extremely doubtful if these plungers ever gain a momentum such as would be acquired by a free fall of 10 inches. That this is the case with many of them at least is evidenced by the fact that they are operating without relief valves, or other devices on the line for lessening the shock caused by the sudden closing of the operating valves.

Relief valves are not commonly used for this purpose as the pressure water which escapes from them is wasted. A small spring-loaded plunger, which will yield to the shock but return the water to the line as the pressure goes back to the normal, is placed near any large operating valve which may possibly be closed suddenly resulting in excessive water hammer. Good sized air chambers operating in the same manner as those on pressure pumps are likewise used for the same purpose.

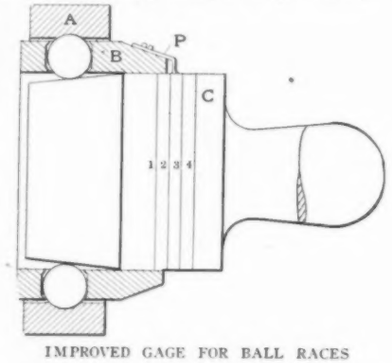
It is also to be noted that the entire shock produced by the drop of a heavy accumulator plunger and its load is seldom taken on the water system; a nest of powerful springs capable of considerable deflection is usually provided to receive the falling mass and act as a buffer. Another method is the use of a throttling valve connected to the accumulator cylinder and automatically controlled to operate and gradually contract the area of the water passages as the plunger approaches either the upper or the lower extreme of its stroke. This method is used on high-pressure elevator systems which are also provided with air chambers as noted above.

GERALD E. FLANAGAN.

Pittsburg, Penn.

A Gage for Ball Races

At page 753, Vol. 31, Part 2, E. Meitner shows a ball-race gage which I believe could be improved upon in the manner indicated in the accompanying sketch. As here shown the plug *C* is turned taper for part of its length and part parallel, the retainer *B* being ground in the bore to receive it. This prevents all possibility of



IMPROVED GAGE FOR BALL RACES

the plug tilting when inserted in place. The lines for showing the amount of radial movement of the balls are placed on the parallel part of the plug.

A pointer *P* held in position on the retainer by a small screw acts as an indicator so that the position of the gage can be readily seen. The hole in this pointer should be slotted so that when the plug wears the only adjustment it is necessary to make to provide a correct reading to lines is to slack off the screw and set the pointer to the lines from a fixed gage of known diameter. The pointer, which can be made of sheet metal may be let into a groove cut in the periphery of the retainer.

Glasgow, Scotland. J. H. JOHNSON.

A Three-tool Boring Head

In regard to Dixie's three-tool boring head, described on page 26, I will say that aside from the difficulty of calipering a three-tool head, I never had any use for one anyway.

A three-cutter tool, if the cutters are evenly spaced, will cut any old shape except round, and if unevenly spaced they chatter. At least that has been my experience.

A five-cutter tool, if made right, will cut smoothly, but three cutters do not support each other properly. However, the use of an uneven number of cutters is as useless in this as in a reamer.

If a boring head has to have several cutters they should be even in number and differentially spaced, the same as a first class reamer, but personally I am not in favor of multiple-cutter boring tools of any kind, if they can be avoided.

Decatur, Ill. ETHAN VIALL.

Heat Treatment of Gears for Automobiles

In reading Mr. Howie's description of suitable steel for the manufacture of gears for automobiles I thought perhaps my own experience with steels, especially in the treatment and hardening of them, would be of interest.

Axles and spindle bearings of a similar nature which were made of from 0.18 to 0.20 per cent. carbon steel, that was case-hardened, failed to give satisfaction under the more severe conditions of solid rubber and iron tires in place of pneumatic.

A series of extensive tests was made and satisfactory results obtained from ordinary 0.30-per cent. carbon steel which had been hardened in calcined leather in the ordinary way. They were first heated to 1750 degrees Fahrenheit, and allowed to cool off in the case. Then they were reheated and cooled off in water with the chill just taken off. Another way was to heat to 1200 degrees Fahrenheit and cool off in oil.

There are many of these running on vehicles of all descriptions from 1½ to 3 tons, and I have not yet seen a broken spindle returned. It requires very careful heating and the air must be, as far as possible, prevented from coming in contact with the articles case-hardened in this way.

Excellent results may be obtained from steel heat-treated as follows: Heat to 1560 degrees Fahrenheit and cool off in water with the chill taken off; then heat to 750 degrees Fahrenheit and cover with lime or fireclay until cool.

For gear blanks 0.58 to 0.6 per cent. carbon with the phosphorus as low as possible, similar to the steel used in Ingersoll pneumatic drills for pistons, would no

doubt give equally satisfactory results with a proper course of heat treatment.

Leeds, Eng. CHARLES STAFFA

Milling Machine Endurance

The illustrations of the milling cutters with inserted high-speed-steel blades and the great work at pages 1 and 41 bring to my mind again, the question: What will be the effect on the machine?

It is now thirty-seven years since I first called the attention of the readers of *Engineering* to the question of equal length-wearing surfaces, and have repeatedly set forth the principle and reported results to the readers of the AMERICAN MACHINIST, and so far as I know, without having won a half-dozen converts.

In the little fifty-cent book which I am giving away, because no one will buy it, I have raised the question whether the beds of such machines as you show driving the wonderful cutters above mentioned, required to be any longer than the tables.

Why planing-machine beds need to be longer than the tables is a question of gravity. If no longer than the tables, the ends would be worn away by the overhang of the table at the ends of the stroke, and wear away the middle of the table.

In the case of the milling machine of the planer type, the pressure of the cutter at the middle of the table tends to do exactly the other thing, and maybe to such an extent as to more than offset the effect of gravity; so that really the bed may need to be in effect the shorter of the two. This question is one so easily determined that it would seem that someone as much interested in the machine as in the cutter, would take the trouble to investigate.

Take any of the machines that originally have scraper marks on the sliding surfaces after a few weeks' or months' use, run off the bed both ways and note where the scraper marks are most worn. If the scraper marks have disappeared in the middle and remain at the ends, the bed is too long, or the table too short, and the thing to do is what we did to the magnificent Pratt & Whitney traversing machine; set a man at it with a bastard file, and cut away 18 inches at one end and 8 inches at the other, as we found the place most worn was a little out of the middle.

When this job is done just right the amount of wear will be 100 per cent. less, and the time when the ways will need to be trued up will be extended to infinity. With all this struggle to get more work out of the tool, it would seem to be worth a little to proportion the machines so as to have them always right, rather than constantly having them wear out of true, and always too bad to use before they get fixed.

Syracuse, N. Y. JOHN E. SWEET.

How It Has Paid One Contributor to Write

The topic "Does it Pay to Write?" has been brought up and pretty thoroughly discussed in these columns. Each writer's view of the subject, from an angle a little different from that of his fellow contributors, is interesting indeed, and it often happens that what he has to say contains something that suggests emulation to the reader. Hoping that the experiences of an acquaintance of mine may be helpful to some ambitious reader, by suggesting a way in which he may make the many little kinks, wrinkles and short cuts he may know, or hear of, assist in his advancement, I present this account of how it has paid one contributor to write.

About 19 years ago he came into the shop as an apprentice; a raw, awkward, country boy, with no education to speak of, except what he had picked up in a few terms at the district school. He plodded along through all the discouraging stages from "kiddom" to journeyman, just as hundreds of you who read these lines have done. He was just the same as the average, an ordinary mechanic with none of the ear-marks of a genius about him.

By and by the microbe of ambition got into his system and created a strong desire for advancement. Painfully aware of his educational limitations, he sought to remedy his defects by home study; in this he was fairly successful. He soon found that a knowledge of mechanical drawing was essential to his further advancement, and all of his spare time was devoted to its study. Drawing materials and instruments made serious inroads into his finances.

About this time he began writing articles for publication, some of which were accepted and paid for. The money he spent in pursuing his studies. As soon as he could make a respectable drawing, illustrations accompanied his articles, which increased the amount of his checks. In this way he continued his studies, taking up a new subject as soon as one was mastered, until he had obtained a fairly good technical education. All of this was done after working hours, and the money necessary for books, etc., was secured by writing articles for publication.

The knowledge gained by this home study has resulted in this young man's advancement to the position of assistant superintendent of a very important department in the largest establishment of its kind in this country. And that is not all; the habit of writing has developed in him what newspaper men call "a nose for news;" he is always on the lookout for interesting material to write up for publication, and in nearly every case the money obtained is spent for some book, or long-desired instrument to be used in the studies for his still further advancement.

New York City. C.

Criticism on Queer Things About Forgings

On page 932 of No. 26, Vol. 31, Part 2, of the AMERICAN MACHINIST there appeared an article entitled "Queer Things about Forgings," by T. Toot, of St. Louis, or was it Toot Toot? After 27 years as an investigator he took a foot bar of 2x4 which weighs 27 2/10 pounds and under an 800-pound hammer drew this out to a bar 2x3x24 inches, which according to table weighs 40 8/10 pounds, a gain of 50 per cent. He then took this 2x3x24-inch bar and upset it back to a 2x4 and then found that it was only 8¼ inches long. This time he had only 66 cubic inches of metal, or 31 2/10 per cent. less than he had in his original bar of 2x4x12. I would suggest to Mr. Toot that he begin making iron from nothing. A good blacksmith would be able to draw 180 bars of 2x4x12 inches down to 2x3x24 inches each day and with each bar he would gain 50 per cent., or 1448 pounds of metal per day.

Begin with ten 800-pound hammers; turn out 14,480 pounds of wrought iron per day and sit back and rest, but be careful, Mr. Toot, not to let your blacksmith upset any bars or you lose.

Mr. Toot is indeed an alchemist such as the world has never before known. Mr. Carnegie, Mr. Frick and others have done very well, but they are but infants in the knowledge of their chosen industries.

Nicetown, Penn. C. W. ADAMS.

The article on "Queer Things about Forgings" made me laugh, as I cannot conjure up a man that can take 96 cubic inches of 2x4 iron and draw it under an 800-pound steam hammer to 144 cubic inches of 2x3 iron. That would change the specific gravity from 7.8 to 5.2 and by a continuance of the process I cannot see any reason why any further desired reduction might not be obtained.

Reversely a piece of 2x3x24 inches or 144 cubic inches is driven together into 2x4x8¼ inches or 66 cubic inches. Starting the job with ordinary stock of 7.8 specific gravity we get some 17 specific gravity.

Think of the possibilities! Iron the specific gravity of gold with a little coating on it and ———, airships of good honest wrought iron having to be anchored to hold them down, engines that will float. Millionaires—pshaw—billionares; trillionares; quad——, but what's the use? Imagination fails. We have been only browsing on the threshold of the land of curious happenings.

Even the Oil Country and the sea are commonplace alongside of this proposition, and Dixie has been wasting his time on the man who made iron to grow and blossom as the rose with such a possibility.

Franklin, Penn. W. OSBORNE.

Class Room Instruction for Apprentices by Public School Teachers

Your editorial on page 32 on the subject of school-room training for trade schools hits the nail exactly on the head in my opinion, with the one exception that I believe that you are unnecessarily fearful about the supply of teachers. "What man has done man can do," and if the man is only an average man there are many who can do what he has done. I like to rate myself along with the average, though some of my friends take particular care that I do not get a swelled head in that direction. Since my case is one exactly to the point it will bear recital.

After spending most of my time from 1886 to 1902 in shops in all capacities that require overalls, and a short time only in shirt sleeves, I had an opportunity to teach. I accepted it, as the polite saying goes; it would be more exact to say that I jumped at the job. My training for teaching was nothing, yet I have succeeded in holding the job and today enjoy double the income that I had in the shop. I believe that there is an abundant supply of men in the shops who can and will do just the same things when the call comes.

What Are the Requisites for a Teacher?

A working knowledge of what he is to teach, a memory of what difficulties he met when he first studied the subject, infinite patience, tact, a sense of humor and a desire to teach, not induced by a fat salary. Knowledge of pedagogy! He is better off without it, judging by the samples I have seen. A trained teacher can take a class of children and in a wonderfully short time teach them to mind and to do any number of things parrot fashion, but they ought not to pass it off as education. Education comes from within, it is not a liniment to be applied externally even though the "hickory stick" worked its wonders many years ago.

A teacher who would educate his pupils in a useful way, can only lead, he cannot drive. He must interest the pupil to think for himself. Readymade thoughts seldom fit and are easily lost. He must go slow. Half the trouble with present-day high schools is that they attempt to crowd too many things into a child's mind too suddenly. Our educators would like to slice off the top of the pupil's head, drop in the whole course of study, sew him up and attend convention till it was time for him to graduate. On the other hand nine children out of ten absorb knowledge readily if they come in contact with it. Of my four children we only to have to teach the oldest. The rest soon know it. They do not "teach" each other. They are simply all playing together. Education is catching as much as the measles, or wearing cuffs.

No false ideas should be entertained about the book-loving qualities of boys who would enter a trade school. They will enter because their parents want them too. They will stay because they are interested and like it or they will stay because they are sure it will pay. A teacher who can interest them will hold more boys than one who can merely hold out the inducement of money. Such a teacher is simply a man who likes boys and likes what he is teaching. If he likes boys he will have confidence in them. He will tell a boy to do something in such a way that the boy will neither say, "I can't," nor "I won't," but simply go to work and try. When the boy is once trying he will guide him, not by taking hold of his hand and moving his pencil, but by a timely question or suggestion, which will change his train of thought.

Discipline

A normal-school graduate will tell you how to keep order, but a man who likes boys will not keep too much order. Boys are wild animals. The slightest show of fear on the part of their trainer and they will down him. They instinctively know their master. Their master is simply a man who can master himself, who can laugh when the laugh is on him, and who can look straight at a boy who is misbehaving and not see it. Talk about eyes in the back of one's head! The average man ought to wear a bandage over one eye when he begins to teach.

Knowledge of the Subject

I said above that one of the requirements was a "working" knowledge of the subject. Many professional educators fail because they know too much. Their minds are so far above their pupils that they overshoot the mark and only a little spent shot falls where it will do good. In my own experience I have always felt that the pupils that I had in my first year's teaching of any subject got more out of it than any succeeding class. The first year I had to scramble to keep ahead of my classes. The difficulties were real to me as well as to them. The next year the difficulties were the same to the new class, but to me it seemed absurd that they should find any trouble in so perfectly obvious a matter. Of course, if a teacher has no pride and is perfectly willing to fall down before a class, his pupils get no help from his inexperience. But I believe that there is an abundance of young men in the shops who would be glad of the chance to take up this work and do it just as conscientiously as they would a job of diemaking.

Do Not Call Them Professors

When the trade schools get these men I hope they will not make the mistake of calling them "professors." We have plenty of professors of everything from shoe blacking to hair cutting, including those whose sphere of action is just under the scalp, without adding to their number. A government-investigating committee with a fine-tooth comb could not find the slightest vestige of a professor's union, though everyone knows that there is one and one of the finest in the land. Serious attempt has been made to limit the membership to those having a degree of Ph.D., though it has never been successful. The limiting hours of labor vary; 16 per week is the average. From that it appears that elimination of work in favor of thinking is the object of the union. It is, of course, understood that the only excuse for eliminating work is in order that the professor may by process of thought solve some new and valuable ideas.

Now the class-room subjects of instruction in a trade school are only such as are very easily learned, and requiring no further development; since they are in common and accepted use it will be seen that the excuse for allowing teachers to join the union is gone. Again, a professor is a professional man, which is only another way of saying that you cannot tell him anything. For example, a doctor! You would never think of calling in a doctor and telling him that you wanted him to give you nine red tablets and three pink ones a day. Just so with a professor! If you hire one the act is *prima facie* evidence that you know nothing of what you are hiring him to do. As for trade-school teachers, they will be merely men who are hired to do something which the directors of the school know how to do themselves. No, you cannot possibly call them professors.

Harder to Get School Managers Than Teachers

I do believe that difficulty will be found in picking the men to take charge of these schools, whether public or private, mainly because neither one can afford to pay for the kind of service that they need. A good, first-class manager for a trade school might not run it any more economically than a poor one, in fact, I doubt if he would take the job unless he had assurance of more money to spend than a poor one would dare ask for. The product of a trade school cannot be measured in money. It will be 10 years after any trade school is started before it will be known whether it is a success; though failure may develop earlier. To say that any plan of action is a success till its first graduates have been out long enough to get their feet under them is absurd. No college would like to be judged by its yearling graduates, and no shop would say that its boys just out of their time represented their ideal workmen.

Boston, Mass. Instructor.

Should Technical School Shop Courses be Reversed?

C. R. Harris, in a recent communication to the AMERICAN MACHINIST, appears to raise a question relative to the arrangement of shop courses in engineering colleges. It is doubtless true that when the question of skill is brought to the front, the patternmaker's trade, or the blacksmith's, for that matter, requires as much ability and is as productive of skill as that brought out in the machine shop. Let us agree for argument's sake that the two first named trades are leaders in their requirements. Does it necessarily follow that in a shop course designed to train graduate engineers in the essentials of manufacturing, patternmaking, or blacksmithing should be given the more prominent place?

Shop courses in engineering are not designed to promote skill, or at least should not be, for manual skill means another development from that of engineering skill. This need not be taken as claiming that the ability necessary to succeed is a whit the less in one case than in the other. The high-grade workman in any of the trades is of necessity a man with fine abilities, and nothing can detract from the truth of this in my opinion. The large fact, however, remains that engineering colleges are not here to teach a trade, but to teach engineering in the shop as well as in the class room or laboratory. A well balanced engineering course, whether in civil, mechanical or electrical engineering, aims to give the student something of a training in all the things he is liable to find use for after his entrance to the engineering world, and to emphasize particularly those parts of his course which are most liable to receive his best energies after graduation.

Take as an example the case of a graduate student of civil engineering. He may, of course, upon graduation, enter the field of engine manufacture, but statistics show that he is not so likely to do this as he is to enter some of the more strictly civil engineering lines of progress. His course in shop engineering is, therefore, made substantially shorter than, for example, his course in field work. This is not because of themselves one of these lines is considered to be of itself of greater or less importance; far from it; but for the reason that for the requirements of civil engineering it is more necessary that the graduate be familiar with field work in all its many phases than with shop practice, and as in a four years' course there is not the time to go deeply into everything offered, he is compelled to magnify some subjects and minimize others.

In the case of the graduate from a course in mechanical or electrical engineering, his large opportunities are likely to be found in the line of manufactures and his training is materially different from the civil-engineering student. So in a shop course for engineering students, the several subjects of patternmaking, forge practice, foundry practice, boiler and engine-room training, and machine-shop efforts are not weighted by their importance as a means of developing skill, but according to their relative importance to the graduate as an engineer. In most of our machine manufactures, as, for example, engine and dynamo building, the manufacture of the various lines of machine tools and the thousand and one other machine lines, the machine shop and the employed machinist become the manager's largest concern. Hundreds of employees in the machine shop to dozens in the others is the usual rule, and the manager's ability to handle the machine-shop problems as they arise must come prominently to the front or he is a failure as far as that business goes.

The shop training which comes next after the machine shop in the manufacture of all machines made from cast metal in part or in whole is the foundry training. As a fact, the foundry end of some lines of machinery manufacturing is far more important to the business than the machine-shop side, but is not usually so. In weighing the several shops when arranging a course of shop engineering, these two should, therefore, receive the larger consideration, and the arrangement should be in the following order of importance: Machine shop, foundry, pattern shop, boiler and engine practice, forge work, with the machine shop occupying one-half of the total time devoted to practice. As I have already said, not for the reason of its being more difficult to comprehend, but on account of its value as an engineering asset. It should for this reason be taken during the closing years of the student's course that he may better realize its importance.

Springfield, Mass. CASE.

Rigidity Test of a 24x24-inch by 8-foot Planer

Entropy, on page 935, Vol. 31, Part 2, brings out some interesting and valuable points, relative to my planer test, and I note that in conclusion, he states that "the planer seems to meet requirements very well," which is true; but is this the best that we can do? In my reply to Mr. Dornbirer's remarks I cited a case of a considerable saving of time in the finishing of some valves, due simply to putting the work on a more rigid machine.

The flat turret, as we have it now, is a most excellent example of progress, along the line of rigidity; most of us can remember operating the turret of 10 or 15 years ago, with its long overhanging tools, and their centers quite a distance above the turret base; still we were able to get economical and accurate results. Some turret-lathe builders were satisfied with that design, because it gave good results; others believed still better results could be obtained and started to get them; so we have the flat turret; Ten years hence, we may have a radical improvement over the present machine in this line, and this because some designer believes the present flat turret can yet be made a better tool. The same argument applies to the planer, or any other tool or line of work.

In connection with the bull-wheel shaft, as Entropy well questions, I have no evidence that the deflection was proportional to the depth of cut; with a cut ¼ inch deep, the bull-wheel shaft gave no deflection, and increases were as already presented; some of the factors, such as workmanship, in boring the bull-wheel shaft bearings might eliminate spring, but I am inclined to think that an adjustment design of the supports at the outer ends of the shaft would very materially reduce the deflection here.

The remarks concerning the head and cross rail are logical, and need no comment on my part, further than such as has been presented.

Relative to the housing deflections, I wrote at some length in reply to Mr. Dornbirer's letter and possibly there may be something there which will answer the questions in the mind of Entropy; there appeared to be a deflection here, even with the rail set low.

Another test on a planer, set on a good concrete foundation would be of value, though there is good reason, in my mind, to believe that the housing deflections under similar conditions would not be much different; at the same time I believe many other readings would be changed somewhat. One of the things which the test shows, is, that even moderate sized planers should be set on a good foundation; not a very common practice, as we all know.

Relative to drawings and detailed dimensions, I am unable to give them, and if Entropy has been in the commercial field, I think he will appreciate the reason; after all, are they necessary for the purpose in mind when the test was made? Here was a modern planer. Under a simple test it showed certain weaknesses; Entropy is a planer builder; he sees this test and notes the results, he has a view of the machine, so knows that it is a modern tool. Will his machine give as good or better results? Test it, by a simple or elaborate method, along the same or by different methods, note the defects, and proceed to eliminate them along practical lines.

The purpose of the test, was to arouse an interest in, and show that, by inexpensive and simple methods, we may find many of the weak points in our machine-shop practice. Knowing such, it is no matter of guess work to improve our methods; at the same time the remarks of both Mr. Dornbirer and Entropy are of great value in connection with the test, as they give other view points to be considered by any designer in this particular field.

Williamson, Penn. JAMES A. PRATT.

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A New Emery Testing Machine

Many of our readers, including all of the older ones, will recall the world-wide interest which accompanied the building and installation of the Emery testing machine at the Watertown arsenal, thirty years ago, and all will be interested in the story of the proposed new Emery machine which we publish on another page. In its day the Watertown machine was, in the matter of capacity, as great a record breaker as this new machine will be, and while others have since been built of greater power, the Watertown machine, considered as an instrument of precision, is, with the exception of the smaller machines which have since been built on the lines laid down by Mr. Emery, unique, as it was when finished. The weighing mechanism of the Watertown machine, which it will be recalled has a capacity of 800,000 pounds, is graduated to read to single pounds, and it will weigh the force necessary to break a single hair just as readily as that required to break a bar of metal requiring its full capacity. It is, we believe, well within the truth to say that, relatively speaking, no chemist's balance is as delicate an apparatus as this machine, while, with all this delicacy, it has been in constant use for thirty years without impairment. When finished it was, as it still is, one of the greatest of mechanical achievements.

The spur which has led to the present undertaking is, of course, the lamentable, not to say disgraceful, failure of the Quebec bridge—the most monumental disaster in the history of engineering—which has brought discredit upon American engineers and engineering, both at home and abroad, to a degree which is of national concern. Contemptuous comments upon not only American bridge engineers, but upon the entire American system of bridge construction, have scarcely yet ceased in our European contemporaries, and, much as one may wince under their unsparing lash, there is, in the light of the colossal failure at Quebec, little that can be said in reply. Something may, however, be done, and that something is to build this machine.

It is undoubtedly true that behind all questions of personal responsibility for the Quebec fiasco is the fact that engineers do not have the knowledge which they should have of the strength of large compression members, which has heretofore been estimated by a process of exterpolation from the results of tests of members of sizes which come within the capacity of existing testing machines. As set forth in the article published elsewhere the Watertown machine demonstrated this process to be unsafe even in the case of simple tension members. Those who understand the obscurities of even the theory of complex compression members will not need to be told that it is still more unsafe with such members, while to others the colossal pile of scrap on the banks of the St. Lawrence river is enough to demonstrate the crying need of this machine. Since it is clear that its construction is impossible by private enterprise, and since the matter is of national importance, it is clear that the Government must undertake the work if it is to be done at all. If precedent is needed, it is supplied by the Government construction of the Watertown machine.

As a national enterprise, no less than as a means of removing a stigma on American engineering which cannot be otherwise accomplished, the machine should be built. It is highly desirable, as the article published elsewhere points out, that the bill be passed during the present session of Congress. This can be materially assisted by calling the attention of members of Congress to its importance, and every reader of this paper should write to his Senator and Representative to that effect at once.

The Coming Influence of the Automobile on Machine Tool Design

Those whose memory of things mechanical goes back to the days of the bicycle boom will recall the great influence which the manufacture of that machine had upon the development of machine tools. The commanding contribution of the bicycle to mechanical progress was the ball bearing, the manufacture of which has developed into a large industry involving numerous new tools and processes. To specify other devices of fundamental importance, it was the manufacture of bicycle hubs which made the forming tool and the oil-tube drill common appliances in the machine shop. These devices were not, of course, originated in connection with bicycle manufacture, but their use had been very restricted, and it was through bicycle manufacture that their possibilities became generally known and their use became common. Another feature of machine-shop practice, which received tremendous impetus through the same influence was the turret lathe, both plain and automatic. Both of these machines were, of course, already common, but their use in most shops was restricted to screw and stud making with a limited application to larger work, and it is unquestionably true that their position as a recognized part of the standard machine-shop outfit dates from their wide adoption in bicycle manufacture.

The automobile today is, apparently, in about the position of the bicycle at the time when the diamond frame and the pneumatic tire had been accepted as final and leading features of the machine Judging from the machines which may now be seen at any automobile show, they

have reached a standard stage so far as their leading features are concerned. Until recently improvements and changes which were not always improvements characterized the industry from year to year, the machine being in a fairly feverish state of rapid development. Unless all indications are at fault, this stage is now passed and automobiling building is, from this on, to become automobile manufacture, and we are led to ask if the influence of the bicycle in machine-tool development is to be repeated by the automobile.

To us this would seem to be not only reasonable but reasonably sure, and when the simplicity of the bicycle is contrasted with the complexity of the automobile it will be seen that the possibilities which now open up are far greater than those which existed in the early stages of bicycle development, and, for ourselves, we confidently look for rapid progress in the development of special machine tools for automobile work.

In this development machine-tool builders must take the lead, as the automobile industry has unquestionably much to learn regarding what organized manufacture means. We have nothing but admiration for the work of automobile designers and builders. They have done a magnificent work which speaks for itself, but the conditions of the industry have, heretofore, made manufacture in the modern sense impossible in it, and, much as we may admire the automobile people as designers and mechanics, it is the simple truth that, with few exceptions, they are not manufacturers properly so called, and many of them have the entire business of manufacturing to learn. If, as we believe, the automobile industry has come to stay and to grow far beyond its present large proportions, it can scarcely fail to offer a fruitful field for the machine-tool designer and one which he should lose no time in cultivating.

Taylor-White Patents Declared Invalid

By a decision handed down by Judge Joseph Cross of the United States circuit court, district of New Jersey, in the case of the Bethlehem Steel Company versus the Niles-Bement-Pond Company relative to alleged infringement of the Taylor-White high-speed steel patents, the case has been dismissed. We understand that an appeal has been taken.

The Making of Large Drop Forgings—Errata

A very obvious error occurred at page 168, due to a mix-up in three-column heads. The heading shown was one for a different article than the one appearing at that page, and should have read, "The Molding of a Large Steel Casting."

Personals*

James F. Murray has been appointed superintendent of the can department of the Pacific Coast Condensed Milk Company, of Kent, Wash.

Harry F. Stimpson, Edward S. Robinson and Herman H. Messroon have been admitted as partners in the firm of Wheelock, Lovejoy & Co., New York and Boston.

Harry M. Chamberlain, formerly superintendent of the Middletown Silver Company has recently joined the engineering force of J. W. Buzzell, New York City.

Charles A. Schieren, Jr., treasurer of the belting concern bearing his father's name expects to sail next week for his annual tour of his company's foreign establishments.

A. G. Christie, chief engineer of the Western Canada Cement and Coal Company, which plant is now shut down indefinitely, has taken up work in the University of Wisconsin as research assistant in steam engineering.

John Cargill has recently entered the service of Robert W. Hunt & Company, and will largely devote his attention to the examination of railway and other corporate properties for which his former experience amply fits him.

Clifford B. Williamson, formerly with the Becker-Brainard Milling Machine Company, and later connected with the Van Dyck Churchill Company, has accepted a position with the Vonegut Hardware Company, Indianapolis, Ind., in the machine-tool department.

B. Raffael, of B. Raffael & Co., Johannesburg, South Africa, is visiting this country for a short time and wants to hear from manufacturers making novel appliances for general machine-shop use. His address for the next week will be Hotel Breslin, New York City.

Camillo Olivetti, president of the C. G. S. Electrical Instruments Manufacturing Company, Milan, Italy, who has been in this country for the past two months with a view to purchasing improved American machinery, sailed for home on February 9, after what he considered an enjoyable and profitable trip.

John W. Dunn, president of the International Steam Pump Company has resigned his position, his retirement from active head of the company being occasioned by ill health. Mr. Dunn is to be succeeded by Benjamin Guggenheim, for a number of years connected with the company in an executive capacity.

Captain Godfrey F. Carden, of the United States revenue service, left last week to continue his investigation of European trade conditions and influences under the auspices of the department of Commerce and Labor. Captain Carden's work in this line last year created widespread attention in machinery and machine-tool circles, and his conclusions were presented in a well written paper read before the last meeting of the Machine Tool Builders' Association where it was received with universal praise.

*Items for this column are solicited.

Obituary

Willie C. Young, vice-president of the Young Machine and Tool Company, Worcester, Mass., died on Jan. 30. Mr. Young was 59 years old and a resident of Worcester for about 40 years. He was prominent in public affairs of his city and was a former legislator, in which capacity he won a record for public spiritedness and important service.

Herbert J. Burroughs, treasurer and superintendent of the Builders Iron Foundry, Providence, R. I., died on January 30. Mr. Burroughs' death came as a sudden shock to his friends and business associates, as he seemed to be in perfect health only a few days previous and left for Pittsburg, where he was found dead in his room in the Fort Pitt hotel.

A New Tool Steel

Due to the litigation over the Taylor-White high-speed steel patents the Continental Iron and Steel Company, of Sheffield, Eng., began experiments for the purpose of producing another tool steel that would not conflict with these patents.

These experiments resulted in their discovering a new combination of alloying materials that is announced as superior to their own high-speed steel "Novo," which is recognized as one of the best grades of high-speed steel, and for this reason they have named it "Novo Superior."

This new steel is best hardened at low temperatures by quenching in water, similar to the process used when hardening ordinary carbon steel. In some of the tests which were carried on by B. W. Winder, the works manager and inventor of the new steel, the steel was hardened 30 successive times in ice-cold water and showed very little deterioration. It also gave a greater cutting power than Novo high-speed steel. The comparison at the end of the thirtieth hardening showed that Novo Superior steel exceeded Novo in the ratio of 28 to 11, when cutting cast steel with 1.50 per cent. of carbon, while in the earlier stages the relative superiority was as high as 6 and 7 to 1.

Hermann Boker & Co., of New York and Chicago, agents for Novo steel, expect to receive a shipment of the new steel in about a month.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Boring Machine with a 6½-inch Spindle

This is an extremely large machine in every way, having a spindle 6½ inches in diameter, which can be fed into the work for a distance of 72 inches, either by hand or power, and fast or slow, as desired.

The construction of the spindle bearings is shown in Fig. 2, the spindle being guided in the cast-iron quill by the taper bushings at the ends, and driven by a key in the usual manner. The front bearings are 12 inches and the rear 10¾ inches in diameter, both being 12 inches long. The spindle is fed from the back end, ball-thrust bearings being provided for feed in both directions. The quill runs in taper bronze bearings which are adjustable, as shown, and which are provided with anti-friction collars and lock nuts for securing the adjustment. The two gears at the front end of the quill give it its fast and slow motion in connection with other speed gearing, which will be shown later, the larger being 48 inches, 2 pitch, 4¾-inch face and the smaller 23⅓ inches, 3 pitch and 3½-inch face. The feed is taken from the gear at the back end of the spindle quill.

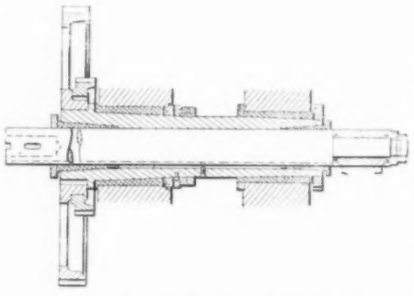


FIG. 2. SPINDLE QUILL AND GEARS

The large clamping collar or bridge is provided to be attached to the large spindle gear to give a rigid backing when a milling cutter is used. The spindle-quill bearings are carried in a large casting which forms the head, and, being without joints, makes an exceptionally rigid construction. The spindle has a vertical range of from 2½ feet to 10½ feet above the table, and the greatest distance between the out-board bearing and the spindle gear is 13 feet, with a minimum of 4 feet.

The rear end of the spindle guide is counterweighted to prevent binding upon the column. Steel graduated strips are provided for both vertical and horizontal adjustment. All operating screws have ball or roller-thrust bearings at each end, and are so designed as to be in tension at all times. This prevents any tendency to buckle. The screws for elevating the head and adjusting the columns are 4 inches in diameter and have a square thread of ½-inch lead. Both of these have a fine hand-operated adjustment, and have bronze nuts in connection with a worm wheel for hand movement. The head is moved by means of a crank while a ratchet

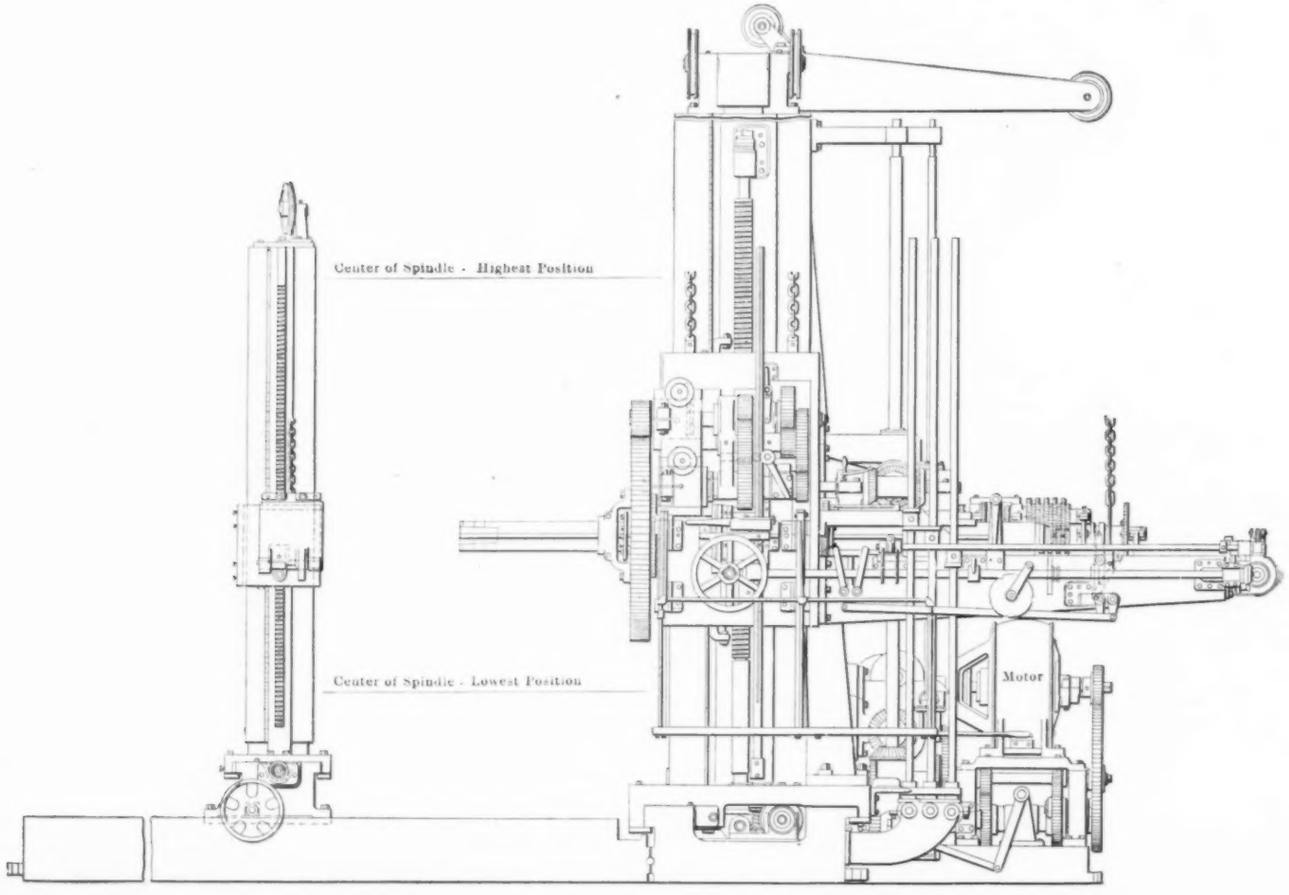


FIG. 1. LARGE BORING MACHINE WITH 6½-INCH SPINDLE

lever is provided for moving the column. The worms act as a lock to prevent turning except by hand as required.

All movements but one are controlled from the operator's platform, which is fastened to the head and moved with it, the only exception being the change of feeds for milling which is accomplished at the rear end of the column bed.

The spindle is driven by a 13-horsepower 1 to 2 variable-speed motor which gives speeds from 1.35 to 85 revolutions per minute, these being suitable for diam-

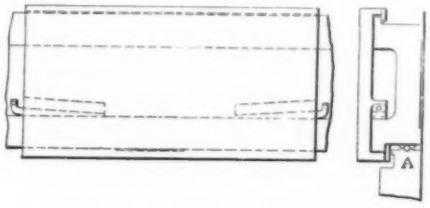


FIG. 3. THE GIBS AND BED CONNECTION

eters from 1¼ to 84 inches at a cutting speed of 30 feet per minute. The gearing ratios are 11.8, 28, 67, 158, and 372 to 1.

Fig. 3 shows the end of the bed and the method of guiding the column upon the bed and the head upon the column. This method of side gibbing gives a very long guide compared with width of guide, and overcomes any cramping action. The other side is simply a bearing surface.

The joint between the end of the platen and the bed is also shown at *A*. It consists of two angular slots, clamping or holding between them several short cylindrical keys. The bolts are close to and above and below the keys. This joint is for the purpose of alining the spindle with the top of the platen, is of the hinge type, and is covered by a patent.

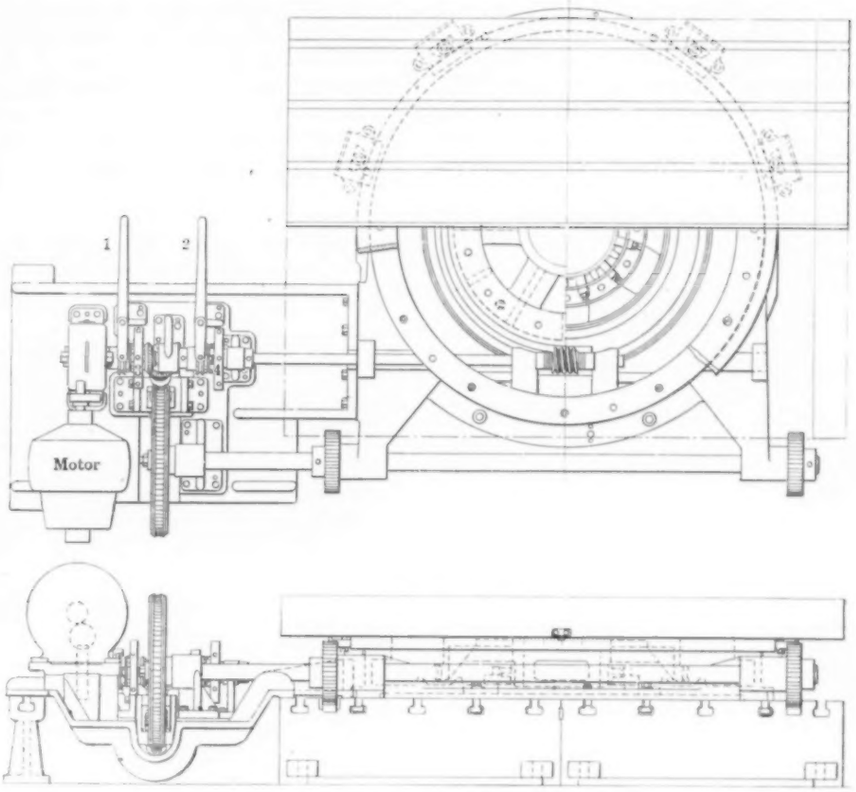


FIG. 6. DETAILS OF THE ROTARY TABLE

The Spindle Feeds

These are driven from a gear on the rear end of the spindle quill so that they are always in direct ratio of the spindle. From the quill the drive goes to the clutch between gears 1 and 2, Fig. 4, which is keyed to the shaft, the gears being loose on it. When the clutch is thrown to the left, gear 1 drives 3 and the first two gears at the right. The smaller of these drive gear 5. They are keyed in pairs so that 6 moves with 5 and drives 7, while 8, also keyed to 7, drives 9 and so on through the train, giving a constant reduction as it goes to the right.

The sliding gear 10 meshes with any of the larger gears of the upper train and in this way gives 6 feeds. Throwing the clutch to the right and gear 2 drives the train through gear 4, giving another set

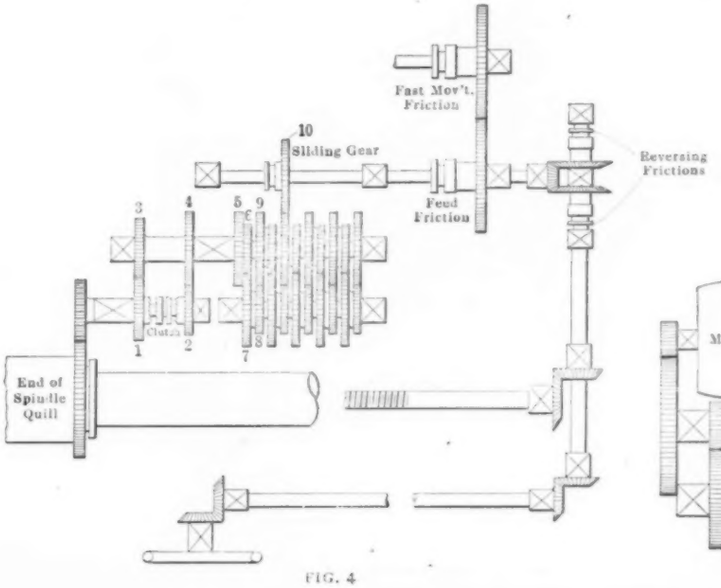


FIG. 4

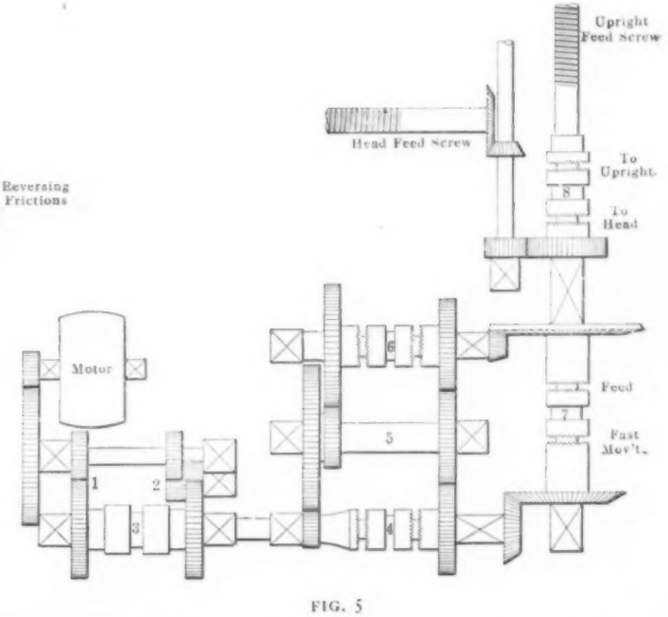


FIG. 5

SPINDLE AND HEAD FEEDS

of 6 feeds, making 12 in all delivered to the sliding-gear shaft and from here to either the fast-moment friction above or the reversing frictions at the right. These drive the feed screw behind the boring bar, with its 1-inch pitch screw and with the power feed clutches thrown out, the wheel in front gives a hand feed for the bar. The feeds vary from 0.038 to 0.75 inch per revolution of the spindle and the fast movement is from 4 to 8 feet per minute.

Head and Column Feed

The head and column feed is driven by a separate motor, also of 13 horsepower and varying from 500 to 1000 revolutions per minute. Direct motion is given through gears 1 while gears 2 give the reverse, these being controlled by friction clutch 3. The clutches are keyed to the shaft in each case and the gears are loose, so that when clutch 4 is thrown to the left it engages one set of gears and another when thrown to the right driving the gears each side of clutch 6 but not the shaft itself. Throwing clutch 6 either way drives the bevel gear on the upright feed screw and the screw itself is driven by throwing clutch 7 up into engagement, when clutch 8 transmits power either to the upright feed screw direct or to the head feed screw through the spur and bevel gears shown. A fast movement to either of these screws can be had by throwing clutch 7 into the lower gear and driving direct from clutch 4.

These give milling feeds of 1 to 16 inches per minute and a fast movement of 2 to 4 feet per minute.

Revolving Work Table

This has a working surface of 6x8 feet, is 7 inches thick, 17½ inches above the main platen and has 8 T-slots, each 1 5/16 inches, planed in the top. It is turned by a 4½-inch worm, 1 inch lead, the worm wheel being 43 inches in diameter and having 132 teeth. Ball-bearing thrusts are provided for each end of the worm.

A 16-inch trunnion centers the table and has means of taking up wear. The circular portion has eight shoes or gibs with binding screws. The ring under the table is graduated to degrees with a pointer on the table having a slight movement for setting.

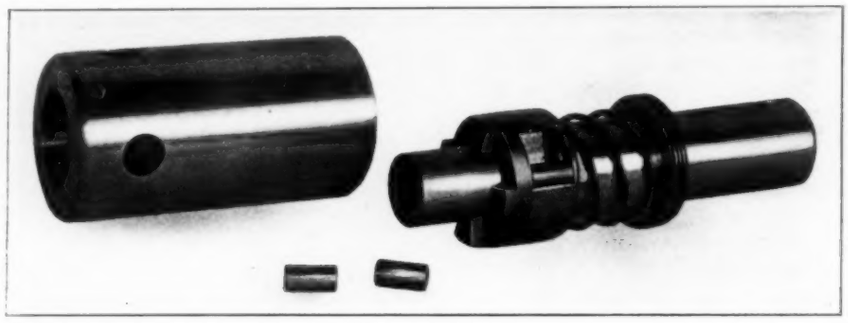
A 5-horsepower motor revolves the table and also moves it along the bed by the same racks as serve for the main column, the table turning once in 2 minutes and the travel along bed being 3 feet per minute. Clutch lever 1 connects the worm for moving table and clutch 2 for turning the table. The motor connection to clutch shaft is by worm gearings as can be seen from the end view. The clutches have large hubs provided with holes to enable fine adjustment by using a bar by hand.

The motor worm and wheel are run in oil in a tight case and the table worm can also be run in oil as the base is provided with a suitable reservoir and the drip can be returned to it. This is one of the largest machines built by Beaman & Smith, Providence, R. I.

Tap or Die Holder

This is a combination of a positive and friction clutch, the former being used for driving the tap or die during the cut, and the latter for backing it off. The positive clutches are of hardened steel securely fastened in place in both the sleeve and the chuck spindle, while right behind the positive clutch is a roller-friction clutch which can be seen with a roller in place.

In operation the positive clutch drives the tap or die until it is pulled out of action by a stop located at the proper depth, and when the machine is reversed the friction takes hold, quickly and quietly, and saves the reëngagement of the positive clutch. This is being made by the Wells Brothers Company, Greenfield, Mass.

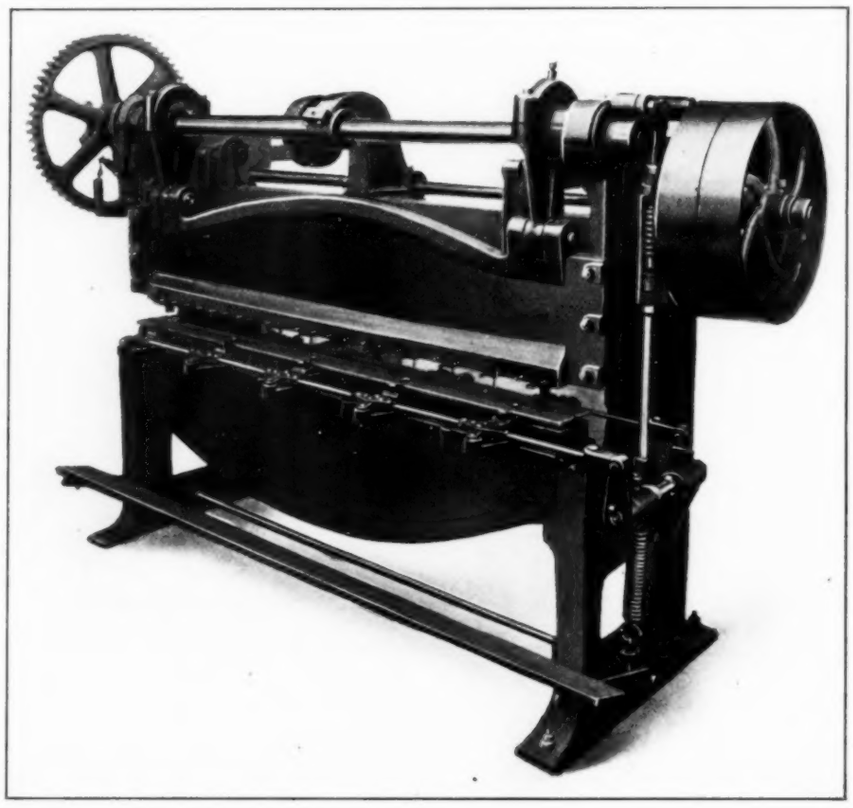


POSITIVE AND FRICTION THREADING HOLDER

Large Gang Punch

The punches and dies in this machine can be arranged for either universal or independent adjustment, the machine shown being equipped for automatically clamping narrow bars or strips. Each machine is provided with a stripper properly designed for the particular work for which it is to be used.

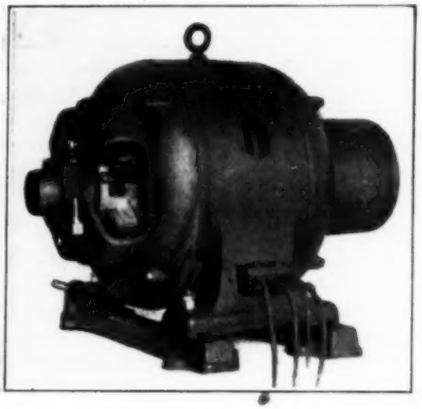
This machine is also built with the same automatic clutch that is used on the heavy gate shears of the same make. It is built in several sizes by Bertsch & Co., Cambridge City, Ind.



GANG PUNCH

Single Phase Motors for Machine Tools

This is an induction motor having a commutator mounted on the rotor shaft and connected to the rotor winding. Starting with the machine at rest, brushes in pairs, cross connected through a low resistance conductor, bear upon the commutator, temporarily short-circuiting the rotor winding and developing a very powerful starting torque on the "repulsion" principle. On attaining full-load speed, by the operation of an automatic centrifugal governor the individual segments of the commutator are all positively connected together, thereby transforming the rotor winding to the squirrel-cage form; the motor then continuing as an induction type machine. The governor at the same time removes the brushes from contact with the commutator to save wear.



SINGLE-PHASE MOTOR

It is not injured by closing or opening the switch at any time regardless of speed or load conditions. If the power service should fail for any reason, the motor returns to the starting condition, and picks up its load when the power comes on again, without the assistance or attention of the operator.

They are furnished for all frequencies from 25 to 140 cycles and in various sizes from one quarter horsepower to forty horsepower capacity. Their variable-speed motor differs from the constant-speed motor, principally, in that it has a commutator of the horizontal type, which remains in service all the time. As the torque of alternating motors varies directly as the square of the applied pressure, wide speed variation may be obtained by varying the voltage applied at the motor terminals. These motors are manufactured by the Wagner Electric Manufacturing Company, of St. Louis, Mo.

Self Starting Devices for Alternating Motors

The Cutler-Hammer Manufacturing Company, Wilwaukee, Wis., has brought out a very complete line of devices for starting alternating-current motors without danger of injury to the motors or otherwise interfering with the operation of the circuit. They are so arranged that all the necessary operations are performed automatically and include five types of starters for single or multiphase motors of various kinds. In addition to these they have a line of float switches for automatically throwing in and out alternating motors connected with pumps, when the liquids in the tanks reach a predetermined level.

Using up Twist Drills with Broken Tangs

The accompanying illustrations show some new appliances by the Standard Tool Company, of Cleveland, O., for using up twist drills of which the tangs have been broken or distorted. Fig. 1 shows their economy tang gage, which when slipped over the shank of a drill with a broken tang as shown provides means for marking a new tang correct in size and position which may then be shaped by milling, planing, filing or grinding as shown in Fig. 2.

To suit the rehabilitated drills, the economy short sockets and sleeves shown in Figs. 3 and 4 are provided. These are similar to the regular sockets and sleeves, but have the driving slot lower down and of larger dimensions to suit the new tang. The shank of the economy sockets and sleeves are of the regular dimensions to fit the standard sockets and sleeves. It will be observed that the new tang is heavier and stronger than the old one.

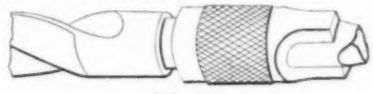


FIG. 1

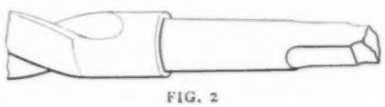


FIG. 2

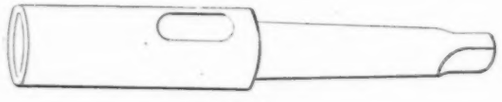


FIG. 3

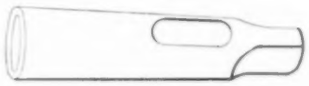
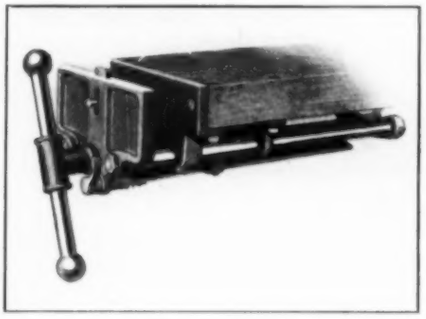


FIG. 4

THE ECONOMY SHORT SOCKET, SLEEVE AND TANG GAGE

Wood Working Vise

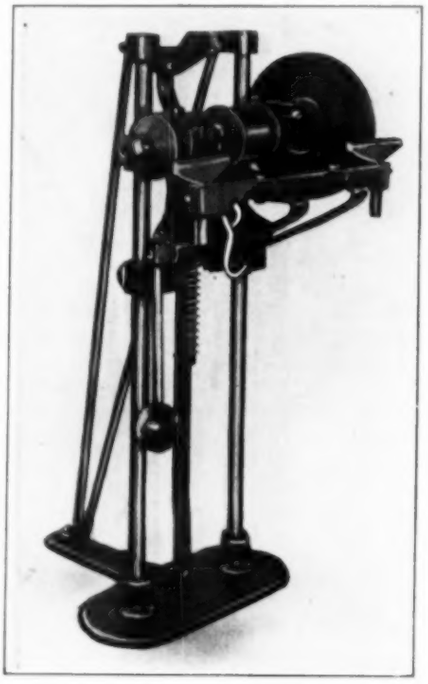
While this has been designed especially for manual training schools, it is equally useful in the pattern shop and makes a quick-acting vise, which is extremely simple in construction. The sliding jaw is guided by two rods, with the adjusting screw between them, while the nut is thrown in and out of mesh by the small lever near the handle shown. A small sliding finger in the movable jaw is extremely useful in many cases, and a taper attachment can be furnished when desired. It is also made with a wood or leather face and is supplied in eight different sizes. It is made by the G. M. Yost Manufacturing Company, Meadville, Penn.



YOST WOOD-WORKING VISE

A Grinder Without a Countershaft

The novel feature of this machine is that the driving belt runs constantly, the



A GRINDER WITHOUT A COUNTERSHAFT

handle with the ball on the end being raised so as to rest on the hook when the machine is idle and be dropped to the position shown when in use.

In the idle position the head is raised so as to be out of contact with the driving belt and, as shown in the illustration, it is brought down so as to secure the desired tension for driving the grinding wheel. The upper half of the arbor bearing is cast solid with the frame, while the removable cap is on the bottom so that the belt strain comes on the solid casting instead of the cap screws of the bearing.

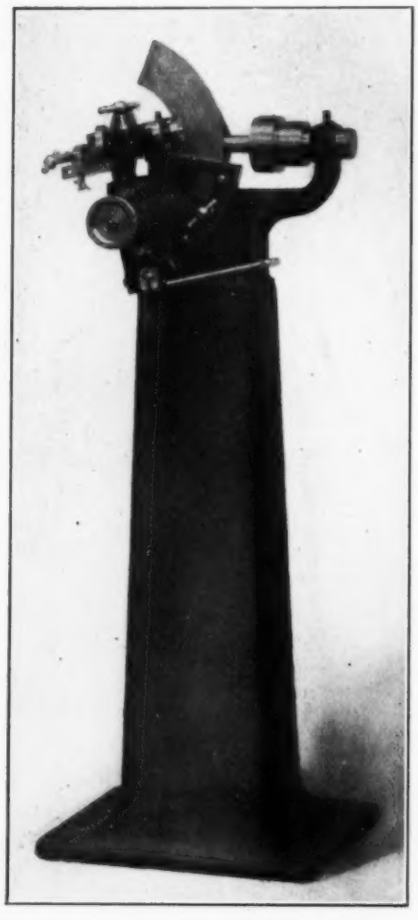
The spindle is 22 inches long and the wheels are 14 inches apart. Wheels from ¾x6 to 2x12 inches can be used and a surface attachment can be supplied to go over the top of the wheels. This is being manufactured by William M. Nicholls, 253 Broadway, New York City.

A Threading Die Sharpener

We illustrate herewith a new die-sharpening machine for sharpening bolt-cutter dies, giving them the proper entrance and correct clearance. It enables each die in a set to do an equal portion of the work, resulting in better threads, and in greatly increasing the life of the dies. It will sharpen any size or type of threading die on the market.

The machine is simple in design, and can be handled by an inexperienced operator. A 6-inch wheel is used, which can be redressed to 3½ inches without affecting the machine's operation. A suitable chart is furnished for making the necessary settings for various diameters, and it is an easy matter to change from one size to another.

To secure satisfactory results from threading dies they must be sharp, with the cutting clearances correct; and to secure a maximum life, they must cut equally. This machine enables these results to be secured. It is built by the National Machinery Company, Tiffin, Ohio.



A THREADING DIE SHARPENER

Screw Cutting Attachment for Bench Lathe

This shows a very simple and practical method of using a screw-cutting attachment in connection with the slide rest on a precision lathe. The gear support is clamped across the end of the bed at the end of the headstock, so that it can be easily removed, and at the same time any combination of gears can be secured with the least difficulty.

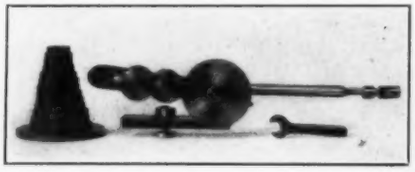


FIG. 1. SCREW-CUTTING ATTACHMENT

Motion is transmitted to the slide-rest screw by the telescoping rod and two universal joints, the whole thing making a very substantial attachment for this work. It is made by the Elgin Tool Works, Elgin, Ill.

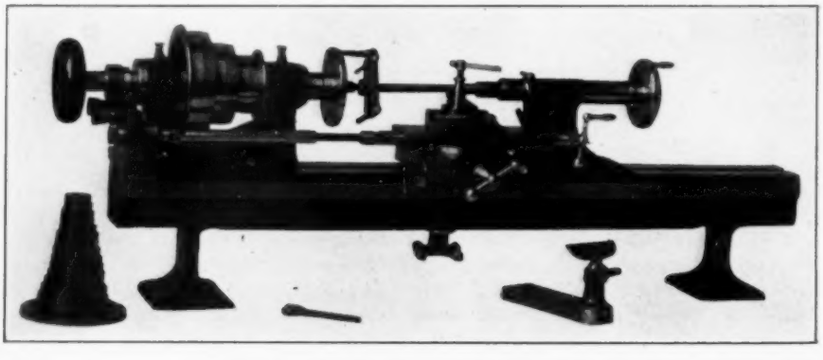
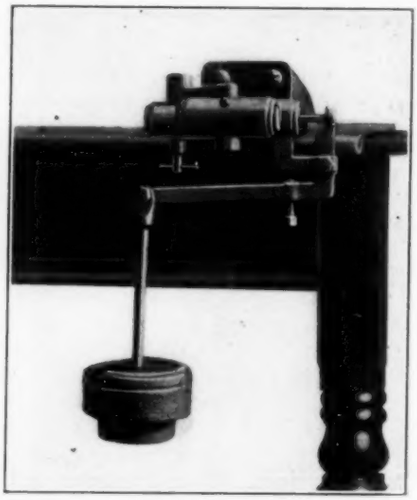


FIG. 2. IN PLACE IN PRECISION LATHE

Unloader for Air Compressor

In the main portion of this device are two cylinders with pistons ground to a fit. The main piston connects directly with the air tank, and the weights are so arranged as to control the air pressure within the desired limits. When the maximum pressure is reached the weight rises and allows the main piston to move and uncover the ports which connect it with the smaller piston. This is moved in turn and connects with the air pressure from the tank, and this reaches the valves of the air compressor, completely unloading it. The variation between maximum and minimum pressures may be from 4 to 20 pounds, but experience has shown that about 6 pounds is the most desirable for general use. After the compressor has unloaded and the pressure been reduced the desired amount, the weights overcome the air pressure on the main piston and allow the small piston to return to its starting point. The compressor then gets to work again, and in this way the air pressure in the tank is controlled without waste of power, as is the case when the safety valve is used on the tank.



UNLOADER FOR AIR COMPRESSOR

The second or auxiliary valve connects the unloading valve direct with the air tank so that its action is dependent entirely on the pressure of air it contains. This can be arranged to control either the inlet or outlet valve of the compressor as may be desired. Both cylinders and pistons are made of brass to avoid any chance for corrosion. They are being made by the Hunneymen Company, Concord, N. H.

The Link-Belt Beneficial Society

By J. R. Shays

It is a well known fact that a large number of the manufacturing concerns in the country have adopted means of creating a personal interest of the employees with the work of the plant; club rooms, gymnasiums, libraries, etc., having been furnished by the companies for the benefit of their employees. There are, however, comparatively few cases of insurance and aid societies having been established in direct connection with the plant. Such an organization as this has been running for some time in the Philadelphia and Chicago works of the Link-Belt Company, and has proved a success in every way.

It is rightly named "The Link-Belt Yearly Beneficial Society," and its object is the relief of its members during sickness, or such other disability as would prevent them from attending to their usual occupation, and to provide for the burial of deceased members. This object is accomplished by the payment of dues and assessments by its members, and by the receipts or contributions from other sources.

THE LINK-BELT YEARLY BENEFICIAL SOCIETY
(OF CHICAGO)
RELIEF COMMITTEE STATEMENT
REGARDING

Name.....
Address.....
When Reported.....
Received Benefits.....
Reported Off.....
Cause of Disability.....
Conditions.....
Name of Attending Physician, or Hospital.....
Physicians' Certificate Presented.....
Visited (Date)..... By.....
Chairman.....

FIG. 3. BLANK FOR RELIEF COMMITTEE REPORT OF LINK-BELT BENEFICIAL SOCIETY.

Year.	Total Receipts.	Paid Sick Benefits.	Deaths.	Paid Death Benefits.	Members at Dissolution.	Paid Dividends.
1901	$1,547.08	$ 908.16	1	$ 207.50	220	$1.70
1902	2,129.51	959.44	2	488.00	250	2.58
1903	2,422.61	1,412.71	4	1,077.51	278	*1.25
1904	2,690.26	1,397.43	3	800.00	297	1.37
1005	2,247.59	1,476.61	1	329.16	334	1.95
1906	3,089.21	2,071.48	1	411.50	399	1.25

*This was the year two men were killed on railroad; dividend was withheld and our assessment was called for 75c. to make $2.00.

FIG. 4. CONDENSED REPORT OF THE LINK-BELT BENEFICIAL SOCIETY OF PHILADELPHIA.

A distinctive feature of this particular organization is that it is decidedly a yearly affair, inasmuch as it is dissolved and reorganized at the end of each year. In this manner, members in arrears, or those who have left the employment of the firm are omitted from the books and the new year is started out with a new sheet uptodate in every respect. The employees have full charge of the management, and membership is not at all compulsory. There are, however, very few of the employees of the plant who are not members.

The initial cost of this society, which was nominal, covering printing expenses, etc., was assumed by the company. After it was well established, all the current expenses were paid out of its own treasury.

Entrance to the society is made in the following manner: Each employee on joining makes out an application blank, which is furnished to him, Fig. 1. When this is received he gives to the treasurer of the company the power of attorney, Fig. 2, authorizing him to take from his (the member's) weekly wages, the sum of 50 cents for that current week (initiation fee), and 10 cents per week for 49 weeks thereafter (dues). This is the expense to each member, who receives in return the full benefits of the society as outlined in its by-laws.

In case of sickness or disability, a report is made to the relief committee, Fig. 3. The member is then entitled to the sum of $5 per week, in case he has been away from his work for seven consecutive days. In event of the death of any member of the society, a special assessment of $1 per capita is made, and the amount thus amassed is paid over to the beneficiary designated on the application card.

The only expense attached to the organization is the salary of the treasurer, $4 per month, the secretary $2, and $1.50 to the three members of the investigating committee. Besides the above amounts there is the carfare expended in visiting the sick, and the printing expenses.

All the officers of the society are

CHICAGO,.....190..

I hereby apply for membership in The Link-Belt Yearly Beneficial Society, and agree to be bound by the By-Laws of said Society.

Name,.....
Address,.....
Age,..... Occupation,.....

I designate as my Beneficiary under the By-Laws of said Society,

Name,.....
Address,.....
Related to me as.....

FIG. 1. APPLICATION BLANK OF THE LINK-BELT BENEFICIAL SOCIETY.

POWER OF ATTORNEY.

WHEREAS, I,.....have become a member of the Link-Belt Yearly Beneficial Society, and whereas, I am an employee of the Link-Belt Company, and expect as such, from time to time, to become entitled to wages.

KNOW ALL MEN BY THESE PRESENTS, That I do assign to the Treasurer of the Link-Belt Company, in trust for said Society, so much of the wages which, from time to time, I may hereafter earn in said employment, as shall be necessary to pay all sums in which, as a member of said Society, I may become indebted; and I do nominate, constitute and appoint him my true and lawful attorney, for me and in my name, to demand and collect from said Company and to receipt for so much of my said wages as from time to time, hereafter, shall become necessary to pay the dues which may become payable by me by virtue of my said membership.

In Witness whereof, I have hereunto set my hand and seal, this.....day of..... A. D. 190..

.....

WITNESSES: [SEAL]

FIG. 2. BLANK FOR POWER OF ATTORNEY FOR MEMBERS OF LINK-BELT BENEFICIAL SOCIETY.

selected by the members with the exception of the board of trustees; this board, consisting of seven, being selected by the president of the Link-Belt Company.

At a stated meeting a month previous to the annual dissolution, after all other business has been transacted, the trustees take preliminary action forming a new society. The second Tuesday in January, after all indebtedness has been settled, the amount remaining in the treasury is divided *pro rata* among the members who may be in good standing upon the books.

Fig. 4 shows a detailed report covering the first six years of the Philadelphia branch of this society, and gives a good idea as to what good an organization of this character can accomplish.

A. S. M. E. Monthly Meeting

The next monthly meeting of the American Society of Mechanical Engineers will be held on February 23, the fourth Tuesday of the month instead of the second Tuesday as usual. The subject of the evening's discussion will be "Safety Valves," introduced by a brief paper by Frederic M. Whyte, general mechanical engineer of the New York Central lines.

Mr. Whyte will discuss the principles of the application of safety valves to steam boilers with special reference to locomotive practice, including questions of design and construction, and the requirements and limitations of valves. His paper will be followed by a general discussion covering marine and stationary practice and conditions existing in connection with low-pressure heating boilers.

The Black Oil Finish on Steel

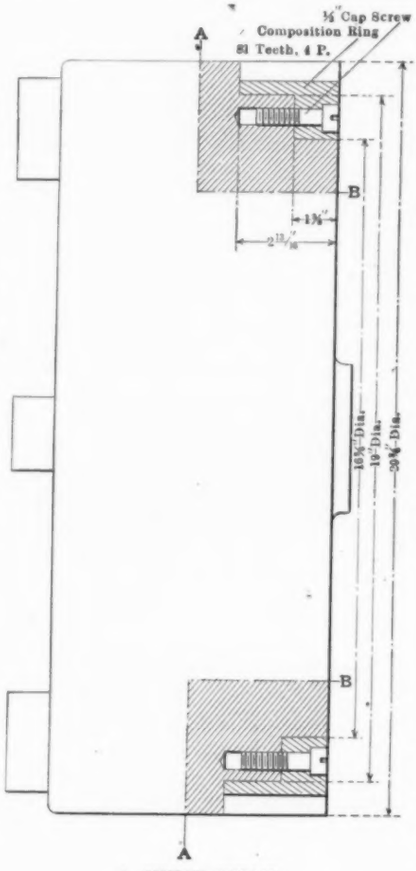
Many articles are found in the market with the black oil finish. It is also known as the burnt oil finish. It is a finish quite extensively used on hardware, particularly mechanics' tools, like wrenches, chisels, pliers, and similar implements. While there are several methods of producing it, one of the best is, according to the *Brass World*, the following:

The article to be finished is heated in a furnace, to cherry redness, and then plunged into oil (preferably lard oil). The article is then removed and the oil burned off in the furnace. After this has been done it is immersed in water. The oil must be kept cold when a large number of tools are to be treated, as the heat will cause it to burn. After the immersion in water, the surface will be found black and protected against rust. In order to bring out the best surface, a light film of linseed oil is applied to the article, and the excess then wiped off.

A Chuck Repair

By G. H. Perkins

On some forms of semi-automatics for heavy work the chuck is driven, when back geared, by a pinion meshing with a gear whose teeth are cut into the periphery of the body of the chuck proper. When these teeth wear out it often means, in the average shop, the expense of an entire new chuck. The accompanying figure shows in partial section at *A B* a method which has been used for repairing such a chuck, and in the particular instance noted, no less than four composition gears have been worn out since the first repair was made. The machine was a semi-automatic turret lathe of Conrad-



A CHUCK REPAIR

son's design built by the American Turret Lathe Company, Wilmington, Delaware. The gear in question was of 4 pitch and 81 teeth. The body of the chuck was first turned down with two shoulders of the dimensions given. A composition ring of corresponding section was cast, turned, and the gear cut upon it. This ring was fastened to the body of the chuck, as shown, by 12½-inch cap screws counterbored with heads flush with the back of chuck. Repairs of this character are the sort that are apt to be neglected by a busy foreman who with much less effort and thought can place an order for a new chuck.

An interesting series of tests are in progress at the engineering experiment station at the University of Illinois to provide a definite record as to the practicability and economy of electric cooking. The tests, which are expected to extend over a period of about three months, will aim to demonstrate that electricity is preferable to other fuels in cooking for an average family of six persons. The necessary cooking ovens, boilers, pots and even electric flat irons have been installed.

Business Items

The mechanical engineering department of the Agricultural and Mechanical College of Texas, College Station, Texas, is overhauling its catalog files and wants catalogs from manufacturers.

The American Specialty Company, Chicago, Ill., reports that its "Use-Em-Up" sockets are in use by the United States government in 27 places, by the Canadian government in 6 places and 2 places by the Mexican government.

The Blanchard Machine Company, Cambridge, Mass., is very busy on contract machine work and has just built a two-story addition for its general offices and drafting room, enabling it to use the room in its works formerly occupied by these departments for additional machine room.

W. I. Reich, mechanical engineer, of Pittsburg, has opened an office at 245 West 24th street, New York, and a shop at 11th avenue and 23d street, New York. His specialty is welding engineering, in which capacity he installed in the last few years several oxy-acetylene welding plants and some electric arc welding outfits.

Announcement is made by the Standard Roller Bearing Company, Philadelphia, of the appointment of F. M. Germane, formerly sales manager, as assistant general manager of the company; T. J. Heller as sales manager, and F. W. Lawrence as Western representative, the latter with headquarters at Chicago.

Business Opportunities

A. B. Stevens, Stuttgart, Ark., will construct canning factory.

Frank Rouse, Augusta, Ga., will establish canning factory.

The Bessemer (Ala.) Soilpipe Company will double capacity of plant.

Tampa (Fla.) Foundry and Machine Company will install electric power plant.

Campbell Iron Company, St. Louis, Mo., will erect foundry to cost about $50,000.

The Stout-Parke Foundry and Machine Works Carthage, Mo., will rebuild burned plant.

The Muhlenberg Machine Company, Dayton, Ohio, has been granted permit to build a factory.

Whitney & Son, Philadelphia, Penn., will erect a $4,000,000 pulp mill near Bryson City, N. C.

The Sanitary Can Company, Frankfort, N. Y., has had plans prepared for a box factory to cost $20,000.

Williams Bros. Mfg. Co., Glastonbury, Conn., making silverware, will erect an additional factory.

The I. X. L. Pump Company, Philadelphia, Penn., is having plans made for an addition to its plant.

C. M. Dunning & Co., Birmingham, Ala., will install sawmill of about 2000 feet daily capacity.

The plant of the Canisteo (N. Y.) Woodenware Company was destroyed by fire, causing a loss of about $50,000.

The Erwin Cotton Mill Company, of Durham, N. C., will erect another mill at Durham or Duke, which will employ 1000 hands.

A. C. Elder, Watkinsville, Ga., will rebuild machine shop recently burned. Will install wood and iron working machinery.

The pattern shops of the Pittsburg Steel Company, at Monessen, Penn., were destroyed by fire. Will be replaced at once.

The Upson Manufacturing Company, of Thomaston, Ga., will build mill for the manufacture of cotton yarns at Forsyth.

The Denver, Northwestern & Pacific Railroad Co. is to build machine shops at Hayden, Colo. Over $1,000,000 is to be expended.

The Hendee Manufacturing Company, Springfield, Mass., is making arrangements to erect an addition to plant. The company builds motorcycles.

The Arkansas, Louisiana & Gulf Railway is said to be preparing to build roundhouse and shops at Hamburg, Ark. J. M. Parker, Monroe, La., general manager.

The Pacific Coast Condensed Milk Company, Kent, Wash., is building plant for the manufacture of cans, which will have a capacity of 600,000 cans per day.

It is stated that the Chicago, Rock Island & Pacific Railway will build repair shops and roundhouse at Crowley, La. J. B. Berry, Chicago, chief engineer.

It is reported that the Baldwin Locomotive Works, Philadelphia, Penn., is contemplating the removal of the major portion, if not all, of the plant to Eddystone.

The Enid (Okla.) Foundry and Machine Works, recently incorporated, will establish plant for the manufacture of implements. Will install lathes, drills, planer, etc. A. C. Lang, president.

H. L. Gilman will soon begin the erection of a large machine works in South Boston, Mass., for the manufacture of hydraulic elevators, engines, valves, plate and structural iron work. Will place orders during March and April for machinery to the amount of $50,000 or more. Present address is 26 Linden Place, Brookline, Mass.

The Agricultural and Mechanical College of Texas, College Station, Texas, will need for its shops and laboratory new equipment, including machine tools, laboratory testing apparatus, air compressor, centrifugal pump and motors. Would also like catalogs for files. Prof. E. J. Fernier, department mechanical engineering, should be addressed.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: Feb. 16—drawing instruments (schedule 901), steel wire nails, steel wire rope, spikes (schedule 903), composition nuts (schedule 906), rolled bronze (schedule 906), steel forgings (schedule 904); Feb. 23—blowers (schedule 923); March 9—hacksaw blades (schedule 915), brass bolts and nuts (schedule 916).

New Incorporations

The Standard Steel Company, Cleveland, Ohio, has been incorporated by T. G. Williams and others. Capital, $40,000.

The Broughton Bolt Company, Cleveland, Ohio, has been incorporated by John S. Broughton and others. Capital, $50,000.

The Novelty Woodworking Company, Dayton, Ohio, has been incorporated. Capital, $10,000. Incorporators, C. Watterman, J. H. Green, etc.

Illinois Metal Novelty Company, Chicago, Ill., to manufacture and deal in metal articles. Incorporators, Geo. E. Mueller, J. G. Kellogg and Wm. H. Feindt, Jr.

Chicago Metal Supply Company, Chicago, Ill. Capital, $10,000. Incorporators, E. F. Parr, L. L. Samp and A. D. Mackay. Will manufacture metal castings.

M. & W. Brazing Co., New Haven, Penn., to braze steel and other metals. Capital, $100,000. Incorporators, A. G. Myers, Albert Hooper and Joseph Whitaker.

The Landgraf Machine Company, Mishawaka, Ind., incorporated by John P. Landgraf, W. A Cook and A. M. Cook. Capital, $10,000. Will manufacture and repair tools.

The World Machine Company, Irvington, N. J., incorporated with $250,000 capital. Will manufacture vending machines. Incorporators, H. M. Brown, F. W. Mills, E. J. Forhan.

The Auto Car Manufacturing Company, Buffalo, N. Y. Capital, $50,000. Incorporators, G. W. Atterbury, G. D. Pratt, E. B. Green, etc. Will manufacture automobiles, etc.

Press Equipment Company, New York. Capital, $250,000. Incorporators, S. T. Walkup, A. S. Goodwin, A. L. Squiers and others. Will manufacture rotary printing presses.

Eberman Auto Appliance Company, Chicago, Ill. Capital, $15,000. Incorporators, J. W. Eberman, E. T. Wilson and W. O. Eberman. Will manufacture vehicles, tools, etc.

McEnhill Manufacturing Company, Detroit, Mich. Capital, $20,000. Incorporators, Thos. M., J. M. J. and A. I. McEnhill. Will manufacture wooden and metal furniture.

William B. Burke Iron and Steel Company, Rochester, N. Y., incorporated to manufacture heavy hardware, iron and steel. Capital, $50,000. Incorporators, William B. Burke, S. M. Hall, etc.

Rochester Can Company, Rochester, N. Y., has been incorporated. Capital, $50,000. Incorporators, M. E. Gray, J. A. Byers, J. D. Lyon. Will manufacture cans and metal goods.

Genesee Metal Company, Gates, N. Y., to smelt, refine and manufacture metals. Capital, $100,000. Incorporators, E. C. Hazard, George R. Coates and F. W. Reidenbach, of Rochester.

The Treaveller Automobile Company, Evansville, Ind. Capital, $25,000. Incorporators, Harry Stinson, Jacob Haas, Adam Brown, and others. Will manufacture and sell automobiles.

Kellogg Manufacturing Company, Rochester, N. Y. Capital, $25,000. Incorporators, G. W. Kellogg, J. F. Weller, M. R. Anstice. Will manufacture automobile tires, pumps, gages, valves etc.

National Association of Automobile Owners, Newark, N. J. Capital, $125,000. Incorporators, F. H. Ramsdell, J. F. Switzer and F. M. P. Pearce. Will manufacture automobiles, carriages, etc.

Interborough Auto Repair and Supply Company, Cold Spring, N. Y. Capital, $15,000. Incorporators, F. A. Verdon, Daniel McElroy, John Roberts. Will build automobiles and electric cars.

Weaver-Ebling Automobile Company, New York. Capital, $25,000. Incorporators, R. H. Weaver, R. W. Ebling, H. H. Pennock. To establish garage and manufacture and deal in automobiles, etc.

The Enterprise Planing Mill Company, Lincoln, Neb., has been incorporated to manufacture store and office fixtures. Capital, $25,000. Incorporators, H. A. Stevens, W. H. Kingery and N. H. Bedell.

The Levett Manufacturing Company, Matawan, N. J., has been incorporated. Capital $300,000. Incorporators, R. Wellman, J. C. Connell, etc Will manufacture dynamos, motors, batteries, etc.

The Lincoln Architectural Iron Company, Rockaway, N. J., incorporated to manufacture iron, steel and other metal products. Capital, $25,000. Incorporators, F. P. McIntyre, J. E. Neylon and J. V. Beam.

Atlas Manufacturing and Stamping Company, St. Louis, Mo. Capital, $50,000. Incorporators, F. M. Wilcox, P. M. Wilcox, August Walz, Jr. Will manufacture and deal in galvanized iron, tin, laundry machinery, etc.

Electric Air Drill Company, Camden, N. J. Incorporated with $300,000 capital to manufacture drills and other compressed air machinery. Incorporators, Chas. H. Haeseler, F. W. Chatlin and Joseph V. Little.

The Makean Laundry Machinery, Binghamton, N. Y., has been incorporated to manufacture laundry machinery. Capital, $10,000. Incorporators, De Witt O. Makean, Binghamton; C. W. Putnam and J. W. Howe, Saratoga Springs.

Trade Catalogs

The Walton Company, Hartford, Conn. Leaflet illustrating and describing device for removing broken taps.

Wm. S. Nichols, 253 Broadway, New York. Leaflet illustrating and describing Economy emery stand.

Goldschmidt Thermit Company, 90 West street, New York. Pamphlet entitled, "Thermit Repairs." Illustrated, 20 pages, 4x9 inches, paper.

Dean Bros. Steam Pump Works, Indianapolis Ind. Catalog No. 74, describing condensing machinery. Illustrated, 56 pages, 6x7 inches, paper.

John Holroyd & Co., Milnrow, Nr. Rockdale, England. Catalog of screw milling machines, twist drill machines, etc. Illustrated, 44 pages, 6x9 inches, paper.

The "O. K." Tool Holder Company, Shelton, Conn. Catalog of tool holders and tools for lathes, planers, shapers, etc. Illustrated, 28 pages, 5x8 inches, paper.

The Hoggson & Pettis Mfg. Co., Catalog E C describing Sweetland lathe chucks. Illustrated, 44 pages, 4x7 inches, paper. Catalog of steel letters and stencils and tools for rubber goods factories. Illustrated.

The Garvin Machine Company, Spring and Varick streets, New York. Catalog D, printed in English, German and French, describing machine tools, including profiling machines, milling machines, tapping machines, drills, etc. Illustrated, 96 pages, 6x9 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

For heavy engineering specialties to manufacture on royalty. Box 878, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Small special machinery designed, working and patent office drawings. Prompt attention. Box 921, AMERICAN MACHINIST.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Special machinery designed, new ideas developed to practical results. Detail drawings made. Prices reasonable. Box 920, AM. M.

Wanted—A 50 to 60" boring and turning mill, two heads preferred. State best cash price, condition and how long in use. Address F. X. Hooper, Glenarm, Maryland.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Wanted—By an established firm, to buy patterns and designs of successful two-cycle gas engines. Ones now on the market with a good record of past sales the preference. Box 890, AMERICAN MACHINIST.

A young energetic man with three years' experience as sales manager of a machine tool concern, now going into business for himself in Cleveland territory, wishes to increase his line. Box 905, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Mechanical engineer, member A. S. M. E., expert on highest grade interchangeable work, 25 years' experience. Competent manager, superintendent or chief engineer. Experience embraces manufacture of automobiles, typesetting machines, firearms and typewriters. Box 913, AMERICAN MACHINIST.

CONNECTICUT

Young man, 10 years' practical experience on accurate tools and dies, 1½ drafting, wishes to improve position. Box 917, AM. M.

Practical draftsman and designer, with wide experience in shop and office practice, seeks position where energy and ability is needed. Box 912, AMERICAN MACHINIST.

Practical mechanic, American, 28, with business experience, would travel or represent reliable firm here or abroad. Speaks German and some French. Box 916, AMER. MACH.

ILLINOIS

Tool room foreman desires change; first class on tools for adding machines, cash registers and typewriters. Box 764, AM. MACH.

INDIANA

Superintendent—Practical machinist and toolmaker. Wide experience handling men and producing results. Age 38. Now employed. Will go anywhere. Box 877, AMER. MACH.

MASSACHUSETTS

General foreman, 22 years' shop experience, five years on automobile construction, wants to correspond with company building commercial vehicles. East preferred. Box 901, AMERICAN MACHINIST.

Wanted—By experienced mechanic, position as foreman of tool room or general foreman of high-class machine shop. Ten years' experience on small and medium interchangeable work. Will locate anywhere for good position. Box 892, AMERICAN MACHINIST.

MICHIGAN

Manager—Factory, sales or general foreign and domestic experience. Age 39, seeks opening with first class company, preferably where interest may be acquired if he makes good. Specialty, gas engines. Hustler, up-to-date, very successful as organizer, producer, systematizer and manager of men. Highest references. Box 911, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman, 25, graduated; wishes to change position; four years' experience at gas engines, pumps and general machine work. Box 914, AMERICAN MACHINIST.

Practical gasolene engine expert and designer is open for engagement as superintendent or general foreman with reliable concern manufacturing automobile or aerial motors. Address, "Straight-line Motor," care AMER. MACH.

NEW YORK

Experienced machine tool draftsman open for engagement. Box 907, AMER. MACH.

Young man seeks position as draftsman; four years' experience. Box 906, AMER. MACH.

General foreman, 25 years' experience, thoroughly acquainted with steam engine work and competent to handle men. "A. Z.," AMERICAN MACHINIST.

Draftsman, experienced in dredging, elevating and conveying machinery, also in general machine work, desires position. Pacific Coast states preferred. Box 908, AMER. MACH.

Designer wishes situation in New York City. Executive ability; 12 years' experience in designing and developing automatic machines. Box 918, AMERICAN MACHINIST.

Superintendent or general foreman, experienced on special machinery and sheet metal stamping. Practical mechanic and good executive. West preferred. Box 903, AMER. MACH.

Mechanical draftsman, technical graduate, large experience in automobiles and gas engines, quick and accurate at figures, thorough practical and theoretical knowledge in applying mechanical principles, desires position. Box 909, AMERICAN MACHINIST.

Mechanical engineer, expert in development of automatic machinery and tools, 16 years' factory experience, technical graduate, thorough and finished draftsman, practical constructor, now employed, desires engagement with progressive concern. Box 895, AM. M.

Expert mechanic now in charge of the manufacturing departments of large plant desires connection with manufacturer to develop improved and patentable features along the line of mechanical specialties. Well versed in the construction of patent specifications. Contract on royalty basis. Address "Q. E. X.," AMERICAN MACHINIST.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreigu sales manager, desires position as latter at London, with A-1 American engineering firm. Thoroughly familiar with English and Continental business; up-to-date hustler. Box A.2, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent Wanted—Experienced in manufacturing and assembling adding machines, typewriters or small tools. Must be educated in mechanics, experienced and qualified to lay out and direct work and to handle men. Should understand factory organization, shop production and economy. Write, stating experience, place and date of birth and salary to go to Canada. Good opportunity and chance for advancement to a wide-awake, progressive man. Address "L. A. W.," care AMERICAN MACHINIST.

CONNECTICUT

Wanted—A live man in every large machine trade center to handle on commission a new and quick selling small tool. Must have trade acquaintances and furnish local references. Box 915, AMERICAN MACHINIST.

ILLINOIS

Wanted—General foreman for the power apparatus shops. Applicant must have good mechanical and executive ability; one with experience in the manufacture of generators and motors preferred, though this is not a necessity. Apply by mail only, stating age, experience in full detail and salary expected. Personal interview may be arranged for later. Address Department No. 29, Western Electric Company, Chicago.

Master Mechanic—We are looking for a man with extensive manufacturing experience on both large and small work for our power apparatus machine shop. Would prefer one who is a good executive, having had a thorough shop training in drafting as well as the various sub-departments of machine shop work. In answer state fully your experience, age and salary expected. If personal interview is desired, it will be arranged for later. Address Dept. 29, Western Electric Company, Chicago.

NEW JERSEY

Wanted—Some first-class patternmakers. Apply Standard Motor Construction Co., Jersey City, N. J.

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

In our rapidly growing business of the manufacture of a well known article, we always have openings for draftsmen and toolmakers on small tools, jigs, sub-press dies and special machinery. We invite applications from first-class men on this kind of work. Box 884, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced man capable of taking charge of gear cutting and hobbing machines. Reply by letter only, stating experience, age and salary expected. Otis Elevator Co., Yonkers, N. Y.

Wanted—A good designer on paper working machinery, also one on automatic wire and sheet metal work. None other need apply. State experience, salary, reference and nationality. Box 910, AMERICAN MACHINIST.

Engineer—We want a technical man for position as engineer of methods. One to do general experimenting and investigating on power apparatus machinery. Must be thoroughly familiar with shop methods and processes. In answer, state fully in detail your experience, age and salary expected. Your answer will be treated in confidence and should a personal interview be desired, it will be arranged for later. Box 904, AMERICAN MACH.

OHIO

Draftsman to design machinery. State age and experience in detail. Address Box 65, Station B. Cincinnati, Ohio.

Toolmaker; one competent to make tools for rolling and drawing sheet metal. Address The Lunkenheimer Co., Cincinnati, Ohio.

Wanted—A factory superintendent by an auto accessory factory with or without experience as buyer, one who has made good in this position with an automobile firm and who has handled a large number of men. Excellent opportunity and chance to secure interest in company if proven right man for the position. Company prosperous and ready to largely increase facilities and output, employing about 500 men. State past experience, names of firms previously connected with, age, salary and full details. Correspondence confidential, if desired. Box 902, AMERICAN MACHINIST

PENNSYLVANIA

Wanted—A man with general machine shop experience and clerical ability to figure prices for estimates and piece rates. Give experience, age and references. Box 887, AMER. MA.

A chief draftsman wanted. A first-class man with wide experience covering hoisting engines and general mining machinery, boiler and steam plants. Prefer a man with college education and of good executive ability. Good wages to a first-class man. In replying state experience and age, giving full particulars. Box 919, AMERICAN MACHINIST.

For Sale

Valuable U. S. A. Patents—For sale outright or on royalty. Improved ball bearings well known in the auto and machine trade on the Continent. Deutsche Kugellagerfabrik G. m. C. H., Leipsig, Plagwitz (Germany).

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Machine-shop Cost Accounting by Machinery

Time and Money Are Saved and a Detailed Analysis Obtained by Using This Machine for Cost Accounting at the Pennsylvania Steel Co.

EDITORIAL CORRESPONDENCE

The tabulating machine is best known in connection with the work of compiling the United States census returns. This is the field for which it was developed, and in which it was first used, but it has since been applied to advantage in cost accounting. Probably the first installation of this kind in connection with machine-shop work was established some four years ago at the Steelton plant of The Pennsylvania Steel Company. Through the courtesy of Gershom Smith, comptroller of that company, we are enabled to present a brief description of the way in which the tabulating machine is used, and the results that are obtained. This description is limited to that portion of the works where, practically, machine-shop practice applies and does not cover the general costs of the steel works which, however, are all gathered with the aid of the tabulating machines.

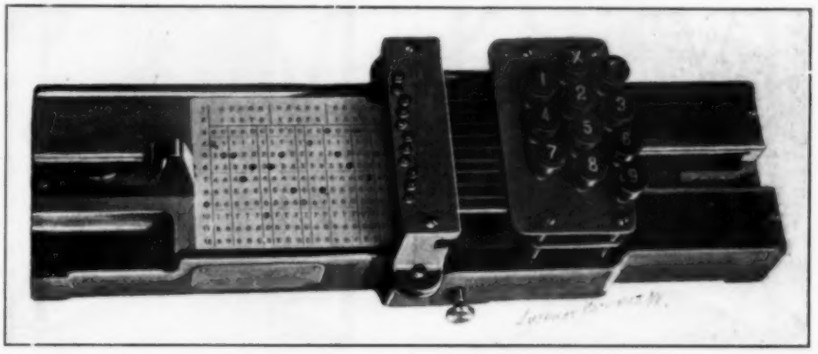


FIG. 1A. THE KEY PUNCH

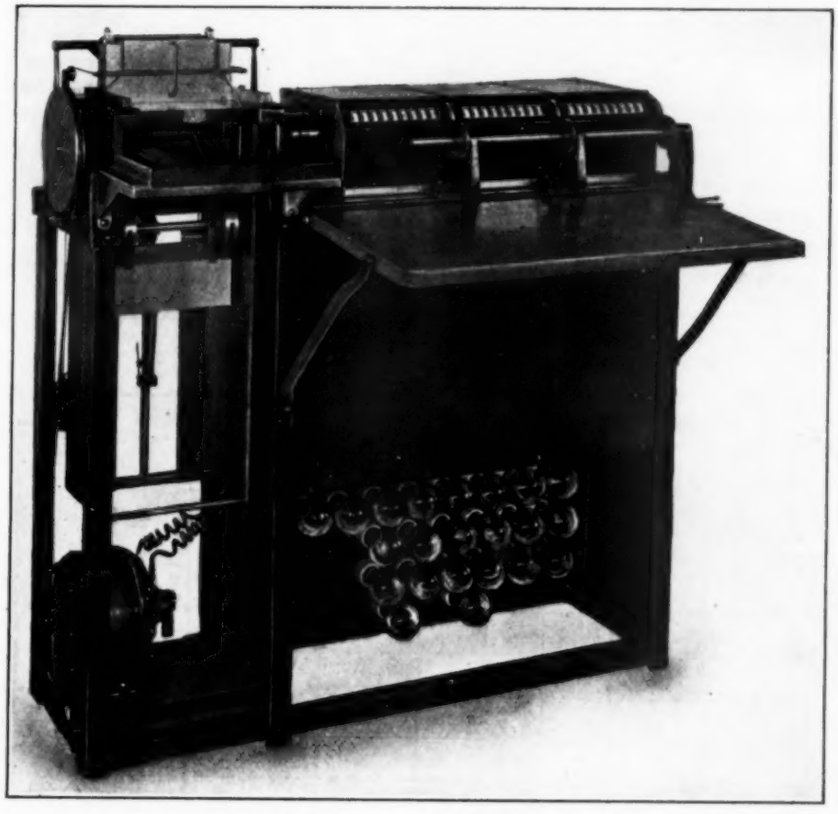


FIG. 1. AUTOMATIC THREE-COUNTER TABULATING MACHINE

The Tabulating Machine and its Accessories

While the general appearance and operation of the tabulating machine is well known from descriptions which have been published in connection with the census, yet it is not out of place to show the machine, touch upon the work which it does, and the way in which it is performed. As used at Steelton an outfit consists of a gang punch, one or more hand punches, an automatic card-sorting machine and an automatic three-counter tabulating machine. The data forming the basis of the accounts, in this system of accounting, are collected by the usual shop methods and are then transferred to a standard machine card by means of punched holes, each hole having a numeral value, or representing a known and classified symbol. A group of these punched cards, which may be without any order whatever, can be passed through a sorting machine once, or many times if necessary, and issue therefrom properly sorted into any predetermined arrangement. The sorting machine handles cards at the rate of 12,000 per hour for each column sorted. This arrangement, of course, is determined by the nature of the data upon the cards. After the sorting into groups, any group may be put into a tabulating machine and total amounts obtained, the individual items of which are represented by the punched holes in the cards. A reference to Fig. 5, which will be described in detail at a later point in this article, shows three cards properly punched to convey certain shop data.

The card-punching machine is a simple device used on a desk or table; the holes are punched by a boy by striking keys resembling the keys of an adding machine.

Fig. 1 shows an automatic three-counter tabulating machine of the type used at Steelton. A group of cards in the act of being totaled is shown at the upper, left-hand part of the machine. At a point a little lower, and beneath the mechanism, is shown another group of cards, in the position in which they are retained after the data which they represent have been transferred to the counters. At the upper left-hand part of the machine are seen the three counters which permit of totaling three independent sets of data at a time. The mechanism is electrically driven and electrically controlled; the driving motor shows at the lower left-hand corner. The control is by means of needles held under spring tension. When

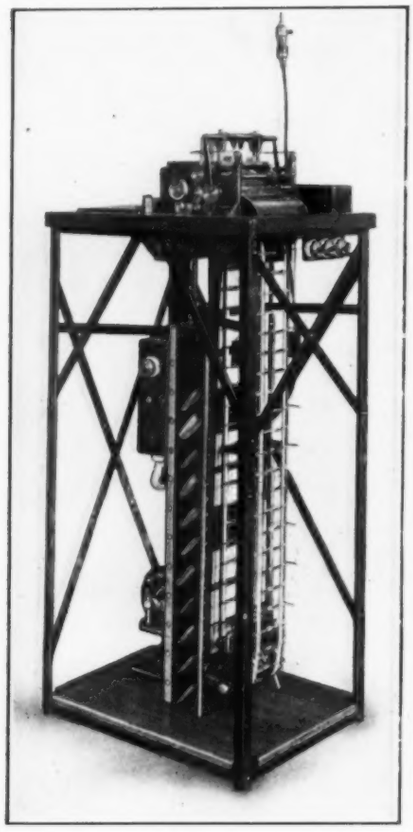


FIG. 2

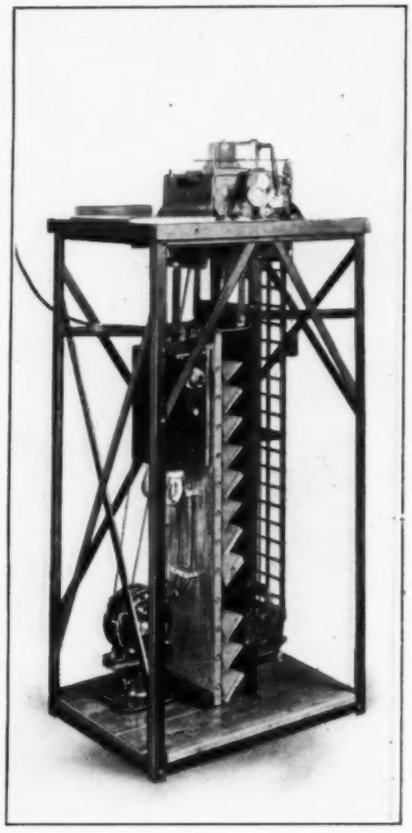


FIG. 3

AUTOMATIC CARD SORTING MACHINE

a card is presented to the machine, the needles which are opposite holes pass through the card, complete an electric circuit and thus operate the counting mechanism. It is possible to have a machine provided with more than three counters, provided the nature of the work demands it.

Two views of a card-sorting machine are shown by Figs. 2 and 3. This machine is also motor driven, the motor being at the base. The illustrations show the point at which the cards are inserted at the top of the machine and also a vertical row of pockets into which they are sorted as the machine operates.

Proportioning the Expense

As one of the cost items that is tabulated by this machine is the expense burden, it is in order to state briefly how this item is established and proportioned. The method is one of the most rational that we have ever seen. The machine shop contains about 150 machine tools ranging from heavy planers and huge, forging-turning lathes down to small tools used for fine tool making. While a certain amount of productive manufacturing is carried on, by far the larger amount of the machine-shop work is in the nature of plant repairs, small tools, new machines and general maintenance. Thus, the problem of properly determining and proportioning the expense burden is somewhat more difficult than in a factory devoted entirely to a given line of manufacture. The method of proportioning is by a machine-rate system based on the number of hours that the machine actually runs divided into the machine's proportion of expense based on floor space occupied, depreciation, power, light, heat, etc. All of the machine tools in the shop are divided into seven general classes. Each class contains machine tools of approximately the same kind. A given expense rate per hour is fixed for each class. This rate was established from a careful analysis of the number of productive hours of all the machines in each class, and is intended to be so fixed that during busy seasons there shall accumulate a book surplus or expense reserve, which will aid in balancing the accounts during seasons when certain machines in any given group may be idle. The proper proportioning of the rate in order to meet these conditions has been, of course, to quite an extent a matter of experience. Still, it has been by no means a difficult problem to solve, and the lessened business activity of the year 1908 has given it a thorough test.

The simplicity and justness of this system of apportioning the expense, together with its successful operation in a plant where the work can be characterized as largely of a jobbing nature and where there is a wide diversity in sizes and

Form 1030 Revised J.T. 450

DEPMT.

THE PENNSYLVANIA STEEL CO.

MAN'S NO. 10

DATE DEC. 22 1908

TIME STARTED A.M. 7 P.M. 6

NAME John Doe

39010

Time Finished	No. Pcs.	ORDER No.	Sub. No.	CHARGE	Mach. No. or Employment	DO NOT WRITE HERE TIME	RATE	COST	
10	9	684120	01	84 J	121-1	3	27½	82½	4 5
11	9	684320	04	91 J	122-1	1		27½	1 5
12	9	682140	09	81 J	134-3	1		27½	3 0
150	9	684120	03	50 J	108-1	1		27½	1 5
250	9	684124	02	72 J	143-1	1		27½	1 5
350	8	684220	07	90 B	802-1	1		27½	1 5
6	6	685120	01	90 F	801-1	2 1/6		59½	3 3
								2	1 6 8
								279	

NO TIME ALLOWED UNLESS REPORTED ON THIS CARD DAILY.

	P. M. IN	P. M. OUT	A. M. IN	A. M. OUT	TOTAL		A. M. IN	A. M. OUT	P. M. IN	P. M. OUT	TOTAL
NIGHT OR OVER TIME	1 27	1 28	1 28	1 28		DAY TIME					

FIG. 4. A SPECIMEN TIME CARD OF THE MACHINE SHOP

kinds of machine tools, should clearly disprove the often repeated statement that the machine-rate method of applying expense is impractical.

The Machine Shop Data

A specimen time card is shown by our line engraving Fig. 4. It is unnecessary to go into the details of time keeping except to state that a time clock is used, and that the time card as exhibited is in the form in which it reaches the office, with the exception of the extensions and totals. These extensions and totals are entered and checked by clerks in the office. It will be noted that the sixth column shows the machine number. This in turn indicates the expense machine-rate which must be charged. It will be noted that for items 1, 2, 4, 5, 6 and 7 this rate is 15 cents per hour; for item No. 3 the rate is 30 cents per hour. The totals show $2.79½ labor cost, and $1.68 expense charge. Each time card represents a day's work for one man.

After these cards have been duly extended, totaled and checked, they are passed to boys who transfer the data to tabulating machine cards by punching holes in proper locations. Fig. 5 shows three cards properly punched for time-card items 1, 6 and 7, respectively. The connection between the written data on the time card and the punched holes is easily traced. Beginning at the left of the card, the first column, numbered from 1 to 12, inclusive, indicates the month; the second column, the day. The uses of the other columns are indicated by the notation at the top. The cards as shown in Fig. 5 are now ready for the succeeding machine operations of tabulating. The actual size of these cards is 7⅜ inches long by 3¼ inches wide.

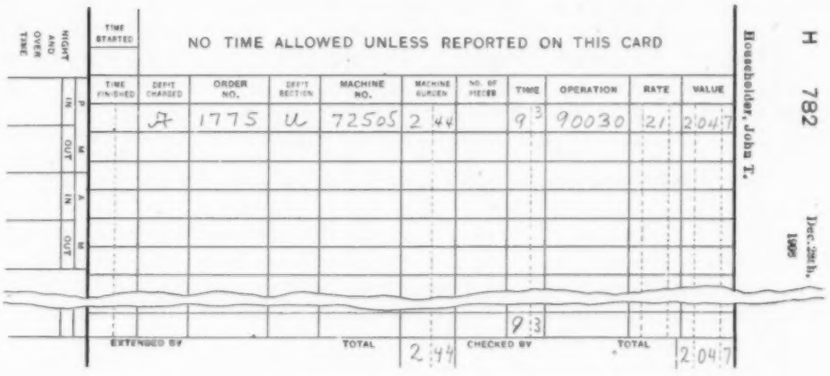


FIG. 6. SPECIMEN TIME CARD OF THE FROG AND SWITCH DEPARTMENT

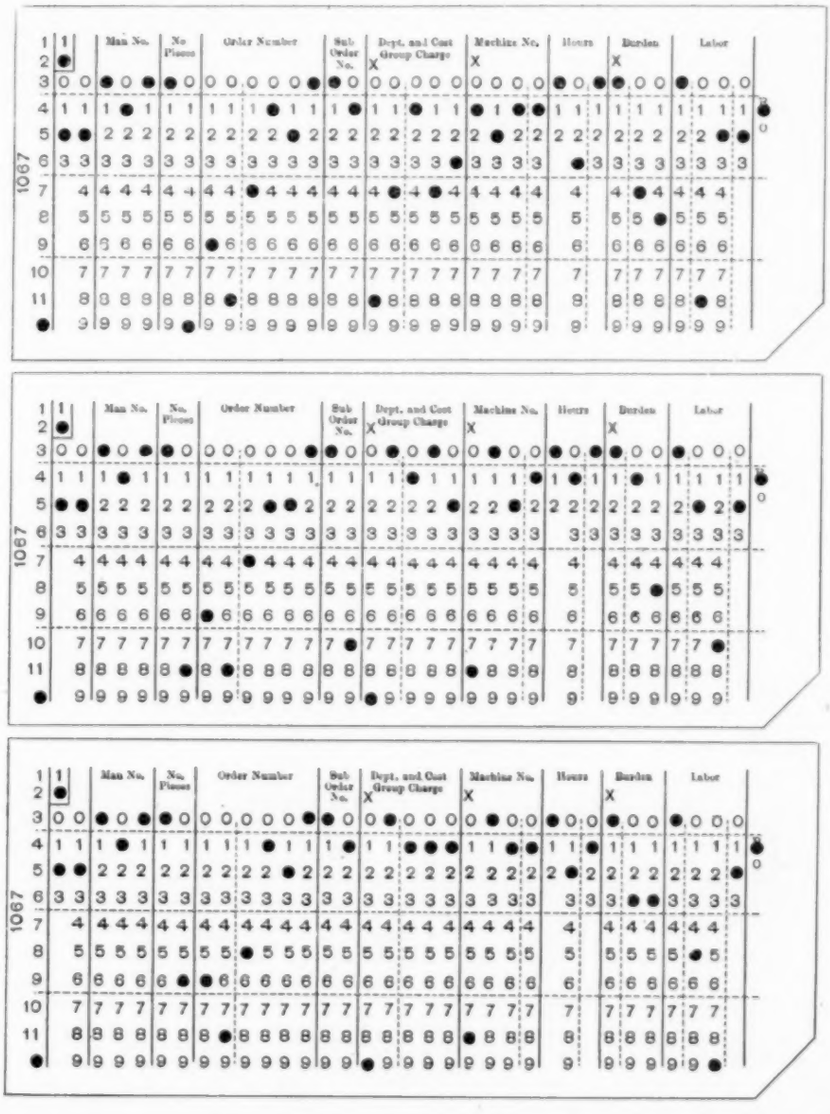


FIG. 5. TABULATING MACHINE CARDS CORRESPONDING WITH ITEMS 1, 6 AND 7 OF FIG. 4

We have now traced the preparation of the machine cards from the machine-shop timekeeping data. As we have mentioned the machine shop proper does work of a jobbing nature. In order to trace the further course of these cards it, therefore, seems better to take up the work of a productive department, for while the underlying principles are in no way different, yet the method of manipulation is better suited to show clearly the possibilities and advantages of machine accounting. The department selected for our purpose is the Frog and Switch department, for while this is a strictly production department its work is also very largely in the nature of machine-shop practice.

Machine Accounting

The time card and tabulating machine card used in the Frog and Switch department are the same in principle as those used in the machine shop, yet they differ in form. Therefore, Figs. 6 and 7 are presented, Fig. 6 shows a Frog and Switch department time card, and Fig. 7 a corresponding properly punched machine card. Each pay-roll sheet is arranged to handle 40 names, as from No. 200 to 239, 240 to 279, 280 to 329, and the like. The time cards are sorted in the office into groups according to the numbers as they show on the pay-roll sheets. Each group is kept separated and the machine tabulating cards are duly punched therefrom.

These groups which now consist of the time cards and corresponding machine cards are passed on to a checker. The checker has by his desk a tabulating machine such as is shown in Fig. 1, and

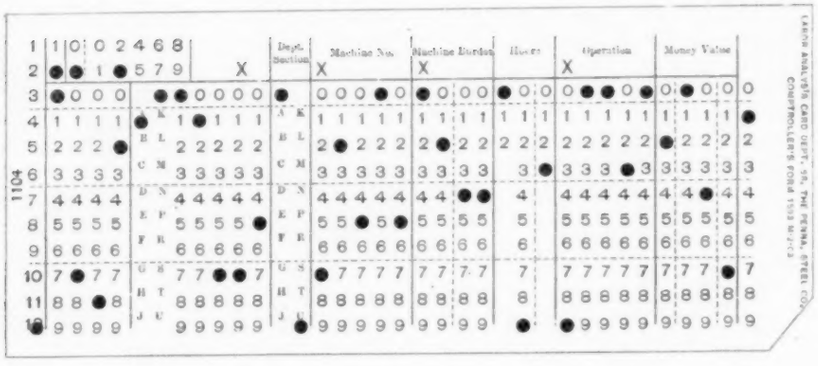


FIG. 7. TABULATING MACHINE CARD CORRESPONDING WITH DATA OF FIG. 6

DAILY PAY ROLL CHECK - FROG & SWITCH DEP'T

DATE

MAN NUMBER	DIRECT LABOR		HOURS	BURDEN		REMARKS
200						
240						
280						
320						
360						
400						
2000						
2040						
2080						
TOTAL						

FIG. 8. FORM OF THE DAILY PAY ROLL CHECK SHEET

an adding machine. The machine cards are run through the machine and three totals are found; namely, the direct labor cost, hours, and expense charge. While the cards are passing through the tabulating machine, the checker totals these three sets of items on the adding machine and notes his results on the bottom card of the group of time cards. When the machine has finished tabulating, the machine-card totals, as indicated on the counters, are compared with the totals obtained by the checker from the adding machine. These totals must check. In case of failure to do so, a search is made for an improperly punched card or for an error in the totals as obtained from the computer. It is a very simple matter to locate an error of either kind and correct it. In passing, it is worthy of mention that the column of figures at the extreme right on the card of Fig. 7 is used to indicate the number of the boy who punched the card, in order that the responsibility for imperfect punching can be placed readily.

The totals from this system of checking are transferred to the pay-roll check, the form of which is indicated by Fig. 8. This is made out daily, and serves as a check for the pay-roll sheets.

Sorting the Punched Cards

Ordinarily, the punched cards go through seven sortings. The first of these is into shop sections, as shown in the third field from the left-hand end of the card. The letters used singly, or in combinations of two, indicate a certain shop section for which it is necessary to find the daily labor and expense charges. Two sortings are necessary in order to group these cards according to these shop section letters; one sorting cares for one vertical row of letters. After these cards have thus been sorted into groups according to sections, they are totaled by the tabulating machine and these totals are properly entered on a "pay roll by shop sections" form, as shown by Fig. 9. The total indicated at the bottom of this slip must check with the total of the daily pay-roll check slip for the same day.

The cards are now ready to be sorted, according to order number. This number appears on the card in the third field from the left-hand end. See Fig. 7. The order numbers are arranged in groups indicative of the character of the production or work that is to be done on that number. Thus, after the cards have been sorted into groups, according to order numbers, these groups are again totaled according to the form shown by Fig. 10. The final total, as given by this form, must check with the total of the payroll by shop sections, see Fig. 9, and with the daily pay-roll check, see Fig. 8.

Two complete distributions now exist: The one is by shop sections and shows

THE PENNSYLVANIA STEEL COMPANY - FROG & SWITCH DEPARTMENT

STEELTON, PA.

PAY ROLL BY SHOP SECTIONS

DATE

Section	PRODUCTIVE			EXPENSE			Section
	Machine Burden	Hours	Direct Labor	Machine Burden	Hours	Direct Labor	
A							A
B							B
C							C
D							D
E							E
F							F
G							G
H							H
J							J
K							K
L							L
M							M
R							R
S							S
U							U
FK							FK
GK							GK
HK							HK
AM							AM
BM							BM
AP							AP
BP							BP
CP							CP
GP							GP
FP							FP
AN							AN
Plant-Insp.							Plant-Insp.
			Productive				
			TOTAL				

FIG. 9. FORM FOR PAY ROLL BY SHOP SECTIONS

the machine burden, number of hours and direct labor for any given day sub-divided under the two general heads of "Productive" and "Expense;" the other shows the same data arranged according to the character of the productive work or expense.

It is unnecessary to show further details of the office system, for it is evident that any further analyses and distributions desired can be obtained readily from the data which have thus far been outlined. The time cards are filed away in the vaults for a reasonable length of time under man numbers; similarly, the machine cards are filed away under order number. At the completion of an order, or at any time during the life of that order, the totals of direct labor, hours and expense can be found by simply running the accumulated cards through a tabulating machine.

		Burden		Hours		Direct Labor	
Street Railway	1000						
Street Railway Repl	2300						
Steam Railway	2500						
Steam Railway Repl	7000						
Temporary Stock	7200						
P. R. R. Stock	7700						
Inter Department	8800						
Bolts and Nuts	8900						
Department L	10000						
Pouring Off	9957						
Department C	900X						
Cores	901X						
Replacements	999						
Expense							
Plant Improvement							
Total							

FIG. 10. FORM FOR DISTRIBUTION ACCORDING TO NATURE OF THE WORK

Material Analysis

The machines are also used for analyzing certain other expense items, in particular those that refer to supplies purchased from outside. In this connection, Fig. 11 shows a requisition on the store keeper for an emery wheel, and Fig. 12 the corresponding properly punched machine card. These material machine cards are printed on green colored stock, while the cards illustrated by Fig. 7 are on canary-colored stock. The use of these material cards will be obvious without detailed description.

Another interesting use of an office machine, although it is apart from the tabulating-machine system, is an addressograph employed for printing part of the data on the pay envelops, also names and numbers on pay-roll sheets and time cards. Fig. 13 shows one of these envelops on which the man's number, name, date and department are printed by the addressograph.

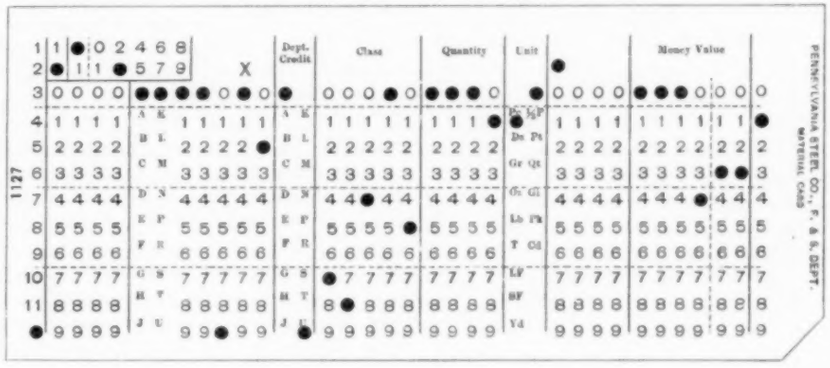


FIG. 12. MACHINE CARD PUNCHED TO CORRESPOND WITH FIG. 11

REQUISITION ON STOREKEEPER

Storekeeper: 12-18-08 Section Date

Please deliver to Department 98 78405

Order No. 902

Weight or Quantity	Description	FOR OFFICE USE ONLY Unit	Price	Value
1	Emery Wheel			
	78405 — 1			+

Signed

THE PENNSYLVANIA STEEL CO.

Frog & Switch Department - Storehouse Shipping Tag

Deliver to Bed No. ____ WANTED A. M. P. M. Filled by

Date Order No.

FIG. 11. REQUISITION FORM FOR SUPPLIES

When it is desired to know how many productive hours a given machine, or group of machines, has worked during a certain period, it is only necessary to sort the cards to that machine number or group number and tabulate. This is advisable as a check on the machine rates and also as an indication of the idle hours of machines. Thus the card has a possibility of tabulating other data than that for which it is primarily used.

Advantages of the Tabulating-Machine System

As we stated at the outset of this article, these machines and accounting methods have been in use for about four years. Thus they have been long and carefully studied and the advantages are clearly defined and appreciated. There are three major advantages: A reduced expense in connection with cost accounting, a lessened time required to prepare the monthly statements and distribution analyses in great detail and of great elasticity. The question of lessened expense is clearly defined from the facts of a reduced office accounting force and the almost entire elimination of night work. The lessening of time in preparing the cost statements is shown from the fact that before this system was installed, the average day on which these statements were received in the controller's office was the fifteenth of each month. This date now ranges from the 5th to the 7th. The question of detailed analysis is shown by the fact that where formerly 27 classes of product were analyzed as regards cost, something like 130 are now thus analyzed. These figures apply to the general business of the company and not specifically to either the machine-shop department or the frog-and-switch department.

The benefits of the tabulating machine

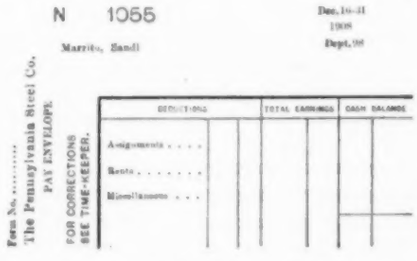


FIG. 13. FORM FOR PAY ENVELOP

in cost-keeping operations of machine shops manufacturing a varied line of parts would undoubtedly be much more striking than those obtained in connection with the work of a steel company. It is to be hoped that the near future will show some such applications.

In closing, it is a pleasure to acknowledge the courtesy of Dr. Hollerith, general manager of The Tabulating Machine Company, 1056 Thirty-first street, Washington, D. C., to whom we are indebted for the photographs used for the illustrations of the machines.

Theory and Design of Friction Clutches

Mechanical Imperfections Must Be Realized, Then a Clutch Can Be Designed for Any Service Desired—Better Called Adhesion Clutches

BY MICHAEL RICHARD CONWAY*

The friction clutch is as much a part of a machine as any other member. If it fails to deliver the power it receives, the machine fails to do its work. This failure is not uncommon; in fact it is common enough to be annoying. Machine builders in general have a feeling of distrust regarding its reliability; superintendents and draftsmen hesitate in attacking a proposition that appears to them to be an endless chain of experiments with failures for results. The mechanical man will talk entertainingly of the progressive improvements made in his machine, but his manner changes when his attention is directed to his friction clutch. His enthusiasm drops a number of degrees; you feel at once that he would rather not discuss a subject that appears disagreeable to him. This feeling is nurtured with the idea that the clutch is of secondary importance, and that it is only an accessory to the machine; detached from it when in use—out of sight, out of mind. This distrustful feeling is not confined to the builders alone, but infects the whole fraternity of users as well. This apathy when examined or diagnosed appears to be due to a disease—indolence of the mind; the same disease that affects the schoolboy when mention is made of his lessons.

When sightseeing in an exposition some years ago, my attention was drawn to an exhibit, that was driven by a quarter-turn belt running from a pulley on the main shaft overhead to a friction-clutch pulley on a jack shaft mounted on the floor to drive the machines on exhibition. A quarter-turn belt is always attractive to an engineer, not for its beauty but rather for its peculiarities. This, with the friction clutch, made a double attraction that was decidedly more interesting than the exhibit. An attendant, noticing my interest in the drive, explained, "At first tight and loose pulleys were used, but the belt (which was 6 inches wide) gave trouble. If we wanted the belt to run on the loose pulley it would work over onto the tight, and when needed on the tight pulley would work back to the loose. To remedy this annoyance we were compelled to use a friction clutch, but it works all right as you see." He spoke in a manner as if to excuse the use of a friction clutch. This was due no doubt to its reputation for sticking when it should slip and slipping when it should hold fast.

*Conway & Company, Cincinnati, O.

Friction Clutches Have Improved but Little in Design

About a quarter of a century ago the friction clutch began to be generally used for driving Yankee lathes; the advantages claimed were the quickness of stopping, the avoidance of belt shifting, the narrow width of the pulleys, and the space saved on the driving line; besides being more mechanical and neater in appearance. The lathes of that period required very little power to drive them—about one-third of the power demanded today for the same size lathe taken at its maximum capacity. Yet we see the same familiar clutches and some very poor imitations of them trying to drive the up-to-date lathe! The question that naturally presents itself is, why is it that while the machine is progressively improved, the friction clutch—the prime mover—is neglected? When the answer is logically sought it will be found in the fact that the mechanics of the clutch are not generally understood. The factors that enter into the design of a friction clutch are not psychological, nor do they require a subconscious condition of the mind to comprehend them. They are plainly physical, and one who carefully studies the theory and principles involved can design a friction clutch with as much pleasure as he would experience in the designing of a complex gear.

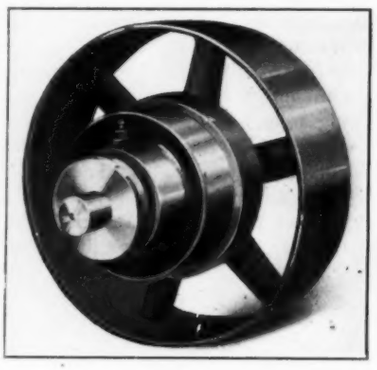


FIG. 1 EXPANSION OR RING CLUTCH

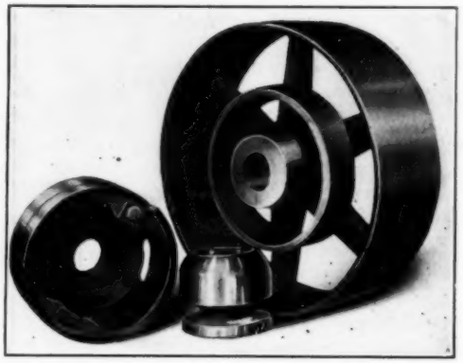


FIG. 2

Limitations of Materials and Workmanship

The construction is of vital importance and should receive primary consideration. A draftsman may understand the theory of his machine well enough, but the limitations due to material, workmanship and methods of construction are handicaps that retard him in attaining anything near perfection. This was forcibly impressed on me by a story that had a run some years ago: A mechanical engineer, well known for his ability, had been retained by a reorganized company to design a steam engine. His instructions were to make the working designs for an engine that would, when running, duplicate a diagram drawn perfectly to the theory of steam expansion. The type, style, construction, etc., were left entirely to his own discretion. He accepted with the agreed understanding that the percentage of variation in the construction from the specifications and drawings should be credited to the diagram.

The theory of friction is very simple: Friction varies directly as the pressure. The unit employed in planning friction clutches is, of course, the horsepower. The contact of the surface is the base by which to determine the dimensions. The factors are the area per square inch of surface, and the pressure per pound. When two carefully planed plates are set one on the other, with their planed surfaces face to face, it would naturally be supposed that the whole area would be in contact, but careful tests prove that the average surface in actual contact is about one per cent. of the whole. In planing a surface the tool leaves ridges, and these are the only points that touch. The furrows are spaces without contact. By the application of expert workmanship in scraping and polishing, a contact of 50 per cent. may be attained. Taking the area of the plate at 100 square inches in the former condition, the surface in contact is one square inch, whi' in the latter it is 50 square inches of useful surface. Cast iron is the material usually employed in the manufacture of machine-tool clutches. This metal has a very open grain having spaces between the particles,

which leaves a considerable percentage to be deducted from the whole area, but it is not necessary to take this into account.

The simplest form of a frictional device is the brake employed to check or stop revolving drums. A band is secured to a fixed support and fitted loosely around the periphery of the drum; each end of the band is connected to a key the handle of which is a lever. By pushing the lever in one direction the band is closed onto the surface of the drum. The friction caused by the pressure of the band on the drum retards or stops it in proportion to the pressure applied by the key to the band. The force of friction required to stop the drum is equal to the force exerted by the drum. The same holds good when the band is attached to another drum instead of the fixed support and the key actuated by some mechanical means. The power of the first is conveyed to the second through friction.

The friction clutch belongs to this second class. The loose pulley carries the power with its hub for a drum. The band is connected through a carrier to the shaft, while the key is actuated by a wedge-shaped spool with a shifting bar for the hand.

The frictional force necessary to carry the power of one member of a clutch to the other may be shown by taking the hub or drum of the above clutch at 4 inches diameter with a face or width of 2 inches. The area of surface is $4 \times 3.1416 \times 2 = 25.12$ square inches. As the band has a space between its ends, 1.2 may be deducted, leaving 24 square inches of frictional surface. The pulley with its drum is turning 100 times in one minute; the periphery of the hub is traveling $4 \times 3.1416 = 12.56$ inches. This reduced to feet gives one foot plus a small fraction; charge this fraction to slippage, and the even number one foot per turn is the result. This multiplied by 100 turns gives 100 feet of space per minute; $33{,}000 \div 100 = 330$ the required frictional force for one horsepower.

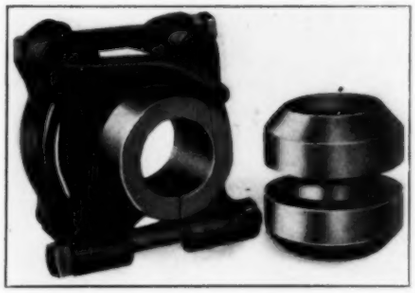


FIG. 3. COMPRESSION OR HUB CLUTCH

Experimental Data

The band has an area of 24 square inches; this into 330 makes the pressure on each square inch equal to 13.75 pounds. This figure would be correct if the whole surface of the band was in contact with the drum, but this condition, as shown before, is not possible. In order to determine a value for the area factor, the foremen in our shop rigged up a countershaft on the floor, under the same conditions that it would be in on the ceiling when in use. The dimensions of the clutch were the same as above; the key had a leverage ratio of 12 to 1; the shifting bar a ratio of 5 to 1. Instead of connecting the pulley with a belt, a lever was attached to it for convenience. The band with its carrier composing the tight member was fastened to the shaft. Securely attached to the shaft was a bar one end of which extended out over an ordinary weighing scales. A notch was made in this bar 20 inches from the center of the shaft; the radius of the clutch, 2 inches, makes a convenient ratio of 10 to 1. The notch in the bar was connected to the platform of the scales by a V-shaped block. The scales was balanced for the weight of the lever and block. The operation was to close the clutch and pull the lever attached to the pulley until it would slip, at the same time noting the weight indicated on the scales. The adjusting screw was set to tighten the band until at the moment of slip the

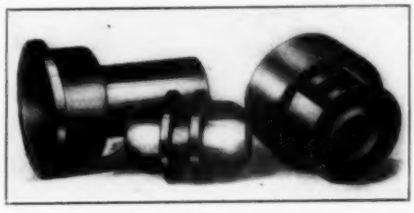


FIG. 4. SLEEVE CLUTCH DISASSEMBLED

scales indicated 33 pounds; this was 1/10 of the pressure at the periphery of the drum for the factor of one horsepower. After the surfaces were lubricated the belt was put on the pulley and run for about 10 minutes with the clutch pressing on the scales; the reading was a few pounds higher at the beginning and gradually diminishing until it indicated 18 pounds. The pressure remained quite steady for a few minutes. The belt was then thrown off and the clutch and pulley were taken off the shaft to be examined. The subject of contact was forcibly brought out when the drum of the pulley and the band were examined. About one-half inch on the inner face of the drum was a polished surface due to the rubbing on the band and indicated the surface that bore the pressure. The same condition was duplicated in the band. The force of contact was shown diminishing toward the center like a shading. The measurements taken proved that the drum was slightly taper. After this faulty workmanship had been corrected a new band was put on and another test made. After this had been made the bearing showed fairly across the face, but for only about 2 inches on each side of the circumference in the band.

These instances go to prove the difficulty of getting anything like a full bearing on every square inch of surface, considering the methods employed in the making of clutches. Averaging from these tests that a contact of 6 inches is available, there is a loss of 75 per cent. to be charged against mechanical imperfection. If perfection were possible, a surface of 6 square inches would be sufficient for a one-horsepower clutch. The

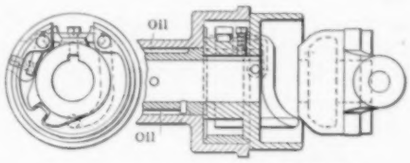


FIG. 5. SECTION OF SLEEVE CLUTCH

pressure per square inch would be $330 \div 6 = 55$ pounds instead of 13.75. To increase the efficiency from 13.75 to 55 offers a big field for improvement, that should not be overlooked by the ambitious mechanic.

Features of Design

In planning for a friction clutch the horsepower that it should develop is the first factor to be considered. The next factor is the speed of rotation in feet per minute at the circumference of the drum; then the area of surface; and lastly, the pressure which may be taken at 15 pounds per square inch per horsepower when good workmanship is the rule.

The key employed to close the band on the drum must be strong enough to resist a strain of 330 pounds per horsepower with a good factor of safety. Its leverage should be ample, that it may be lifted easily by the force of the thimble or lifting device. The thimble is usually actuated by a shifting bar operated by the hand. The necessary force exerted by the thimble should be based on the maximum horsepower, as a clutch is always set for the hardest work it has to do. The shifting bar should move easily. A force exerted by the hand of 10 or 15 pounds should be the utmost.

As the total pressure increases with the horsepower, so does the pressure per square inch. Taking the horsepower at $5 \times 330 = 1650$ total pressure, the pressure per square inch will be $15 \times 5 = 75$. As the key exerts the total pressure in closing the band its leverage should have the highest ratio possible. Assuming a ratio of 12 to 1, a force of 138 pounds must be applied by the spool to lift it, the shifting bar having a leverage of 5 to 1, calls for more than 27 pounds of work for the hand to do. Any advantage that may be in the wedge shape of the spool is counteracted by the friction in moving it.

In computing the values of the different parts, an ample factor must be allowed for weak points and rough usage.

In considering the style of clutch to be designed, the first thought should be given to the forms that can be machined with ac-

curacy; then the parts that are essential and no others. It should be borne in mind that the diameter increases as the width diminishes. Allowing for a pressure of 15 pounds per square inch the surface will contain 22 square inches ($330 \div 15 = 22$). If 1 square inch is taken for the width, the circumference must be 22 inches. This gives a diameter of 7 inches which is altogether out of proportion for a hub clutch. In a case of this kind a ring cast to the arms of the pulley and bored to size with the band made to fit inside, answers the purpose equally well.

The peripheral speed increases as the diameter increases. If at a diameter of 4 inches the drum travels 100 feet per minute, a drum 12 inches in diameter with the same number of revolutions will have a peripheral speed of 300 feet per minute. Friction produces a great amount of heat. The latter speed will create three times as much heat with the same pressure and in the same time, as the former. As lubrication is essential for the protection of the surfaces, the speed should not overreach the degree of heat that the oil will withstand. Centrifugal force is an evil of high speed to be guarded against. It tends to throw the oil off the surfaces, and will close the band if the key lever should be too heavy.

A fact that appears paradoxical, accepting the theory of lubrication as we understand it, is, that it relieves or absorbs friction between moving surfaces. In making a test, as described before but under high pressure, it developed that the pressure on the scales was 1/5 greater with the surface lubricated with mineral oil than when dry, under the same conditions and with the same pressure; in other words 20 per cent. greater efficiency gained by the added friction of lubrication.

Adhesion Clutches Rather than Friction Clutches

The term *friction* in relation to clutches, is misapplied. *Adhesion* would be more appropriate. We conceive friction to be a force due to the resistance of two bodies with different motions while in contact. When the motions cease to be different friction ceases. A clutch is composed of two bodies, one in motion the other at rest. When the body at rest is put in contact with the body in motion it begins to move, gradually increasing in speed until it has the same motion as the other. They are then in a state of rest in relation to each other. As there is no difference of motion, there is no friction; consequently there must be adhesion. If the theory of clutches was founded on adhesion a clearer conception would be given to an obscure subject. The five accompanying figures show familiar types of clutches as made by Conway & Co., of Cincinnati, Ohio; types that illustrate principles laid down in the foregoing paragraphs.

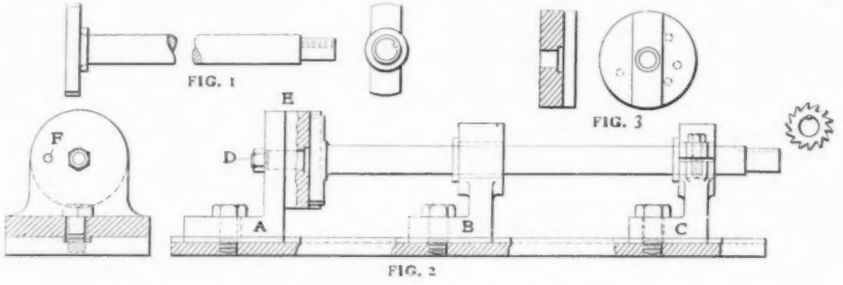
Fixture for Milling Corliss Valve Stems

By H. L. Dean

On a certain make of air compressor employing rotary inlet valves, the valve stems are of the usual form, as shown in Fig. 1, but the positions of the keyways for the arms, with regard to the center line of the heads of the stems, vary greatly for the different sizes and types of machines. As these stems are made in large lots it was formerly the practice to place them in stock with the keyways uncut, and when used in erecting a machine, to employ set screws in the hubs of the arms until all adjustments in the valve gear were made, and the valves finally set. The positions of the keyways on the stems were then scratched from the keyways on the arms when the whole gear was necessarily dismantled so that the stems could be milled according to the scratch marks. When this operation was completed the entire air-valve gear of the compressor had to be reassembled.

On account of the enormous loss of time due to erecting and then dismantling a machine, and the impossibility of supplying interchangeable parts for repairs, the accompanying fixture was designed to hold the stems during the milling operation, the varying angles for the different sizes being correctly determined and marked on the fixture.

Fig. 2 shows an end and side elevation of the complete rig as mounted on the milling machine. The headpiece *A*, guide *B*, and tailpiece *C* are all tongued to fit a slotted block which is clamped to the table. On the stand *D* in the head *A* is mounted the slotted disk *E*, shown in detail in Fig. 3. This may be turned around *D* and locked in various positions by the pin *F*. Each one of these positions is determined by reference marks on the head and on the disk, as shown, each set of marks being designated by the piece number of the stem corresponding. The locking holes are so arranged that the pin will not go in unless the proper marks coincide. One disk is made to accommodate all stems which will fit in its slot, and it can be quickly turned to its proper position and locked. Sets of bushings are provided for the guide *B* and tailpiece *C*, these bushings all having the same outside diameter while the inside diameters vary to suit the different shanks on the valve stems. By various combinations of four sizes of bushings and four disks a line of 26 different stems was accommodated. When placing stems in the fixture it is only necessary to loosen the clamp nut in the tailpiece *C* and the holding-down bolt in the headpiece *A*, when the latter may be slid along its tongue far enough to allow a stem to be slid through the bushings. The head is then slid back into place, the head of the stem fitted into the slot, the clamp nuts tightened, and the keyway may then be cut. To obtain accuracy and uniformity in the sizes of keyways two cutters are used. By this method 40 stems require about eight hours for finishing, which gives an idea of the saving over the old procedure, and at the same time insures an interchangeable product.



MILLING FIXTURE FOR CORLISS VALVE STEMS

A subject that has provoked considerable discussion during recent times, particularly in the heating and ventilating fraternity, has been the relative efficiency and resistance to corrosion of the different types of radiators, with special reference to the advantages set forth by the advocates of the new form of sheet-metal radiation. In connection with this subject it is interesting to note that the conclusions read before the American Society of Heating and Ventilating Engineers early last year to the effect that steel withstands better the corrosive impurities of water than does wrought iron were substantiated by experiments conducted by Professors Howe and Stoughton, the results of which contained the conclusion that wrought-iron skelp, though from the best makers, pitted in seven months much deeper than the steel did in 13 months. The series of tests from which these conclusions were obtained were very minutely carried out, and in the discussion that followed the reading of such conclusions many speakers maintained that their experience showed the same results, while some were of the firm opinion that sheet-metal radiation possessed even greater advantages than those that the experiments showed.

Safety Appliances in German Machine Shops

Simple Guards and Operating Devices Protect the Workmen from Bodily Injury—Some of Them Might Be Adopted in America

EDITORIAL CORRESPONDENCE

An article printed in last week's issue, page 209, presented an analysis of a large number of machine-shop accidents that occurred in a representative shop of this country. Certain points are indicated where safety appliances might be developed and adopted, and thereby minimize certain classes of such injuries. It is well known that the important industrial countries of Europe have done much more than ours in requiring the use of appliances and devices that will protect industrial workers from accidents and injuries from machinery, dust, fumes and other agents. It is the purpose of this article to show by means of illustrations some of the devices applied to machines in the machine shops of Germany. In general these appliances touch upon elements of the mechanism of machines which have been shown to produce serious injuries in the accident analysis article to which we have referred.

We are indebted to Dr. William H. Tolman, director of the Museum of Safety and Sanitation, New York City, for the photographs from which the 21 illustrations in this article have been made. These photographs were taken from the extensive collection of the museum and were selected from the files dealing with German devices.

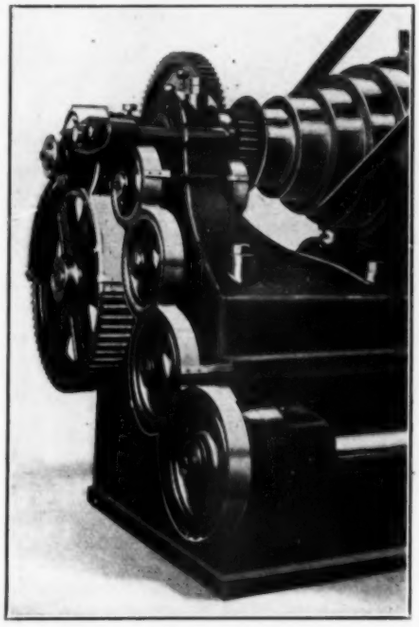


FIG. 1. TYPICAL GERMAN GEAR GUARDS

But very little description is necessary in reference to these half-tone illustrations, other than to mention the particular factory to which they should be credited. They are not presented with the idea that they are applicable, as shown, to American conditions, but rather to show the lines along which development has taken place in Germany and to serve perhaps as suggestions as to what might be, and should be done, in this country to develop rational safety devices for certain dangerous machines and for certain hazardous operations.

Gear Guards

Fig. 1 is presented as a typical method of guarding lathe gears. The tool is a shaft-turning lathe of the locomotive and machine-building firm of Hohenzollern Actiengesellschaft in Dusseldorf-Grafenberg.

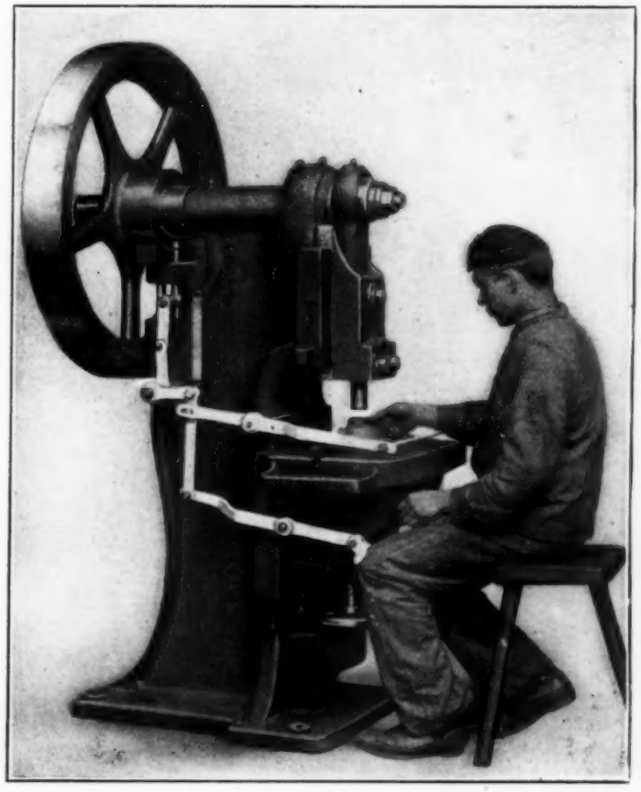


FIG. 2

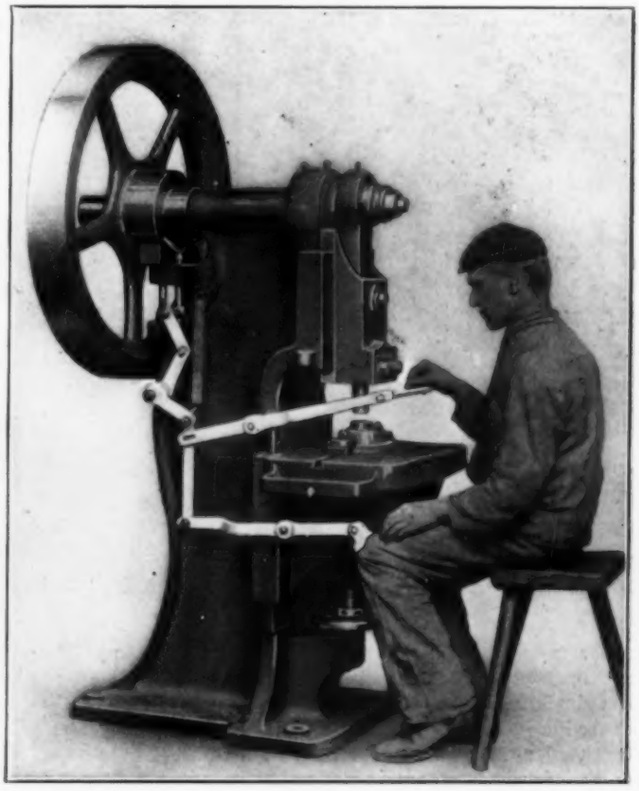


FIG. 3

A PUNCH PRESS SAFETY DEVICE

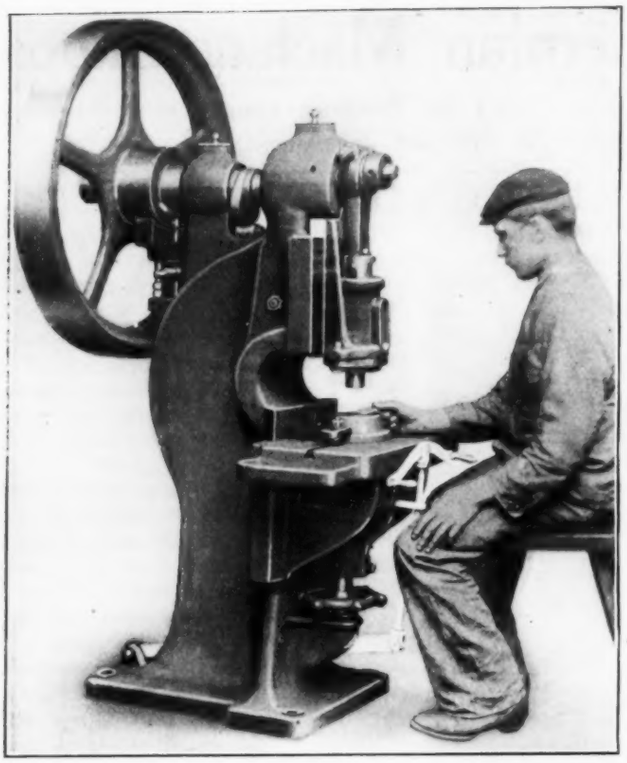


FIG. 4

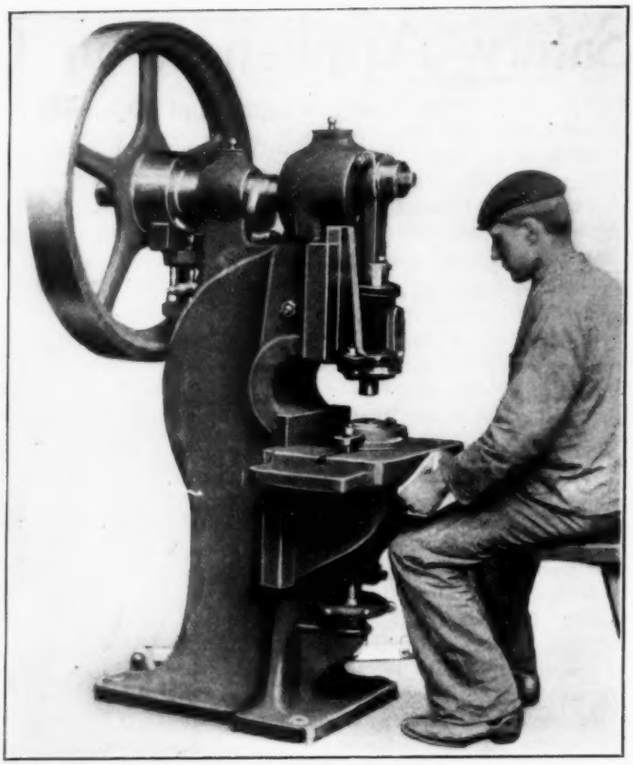


FIG. 5

ANOTHER PUNCH PRESS SAFETY DEVICE

Punch-press Devices

Figs. 2 to 7, inclusive, show devices applied to punch presses. The devices in Figs. 2 to 5, inclusive, are from the firm of Hiltmann & Lorenz, Maschinenfabrik of Aue in Schlesen. The first consists of

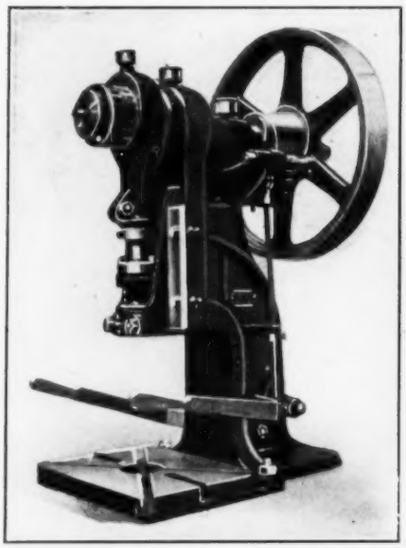


FIG. 6. SAFETY DEVICE FOR A SMALL PUNCH PRESS

a bar carried across in front of the die, and operated by the knee lever that trips the clutch. The first part of the motion of the knee lever raises the bar and throws the hand of the operator away from the die before the ram of the press makes its downward stroke. See Figs. 2 and 3.

The device shown in Figs. 4 and 5 is

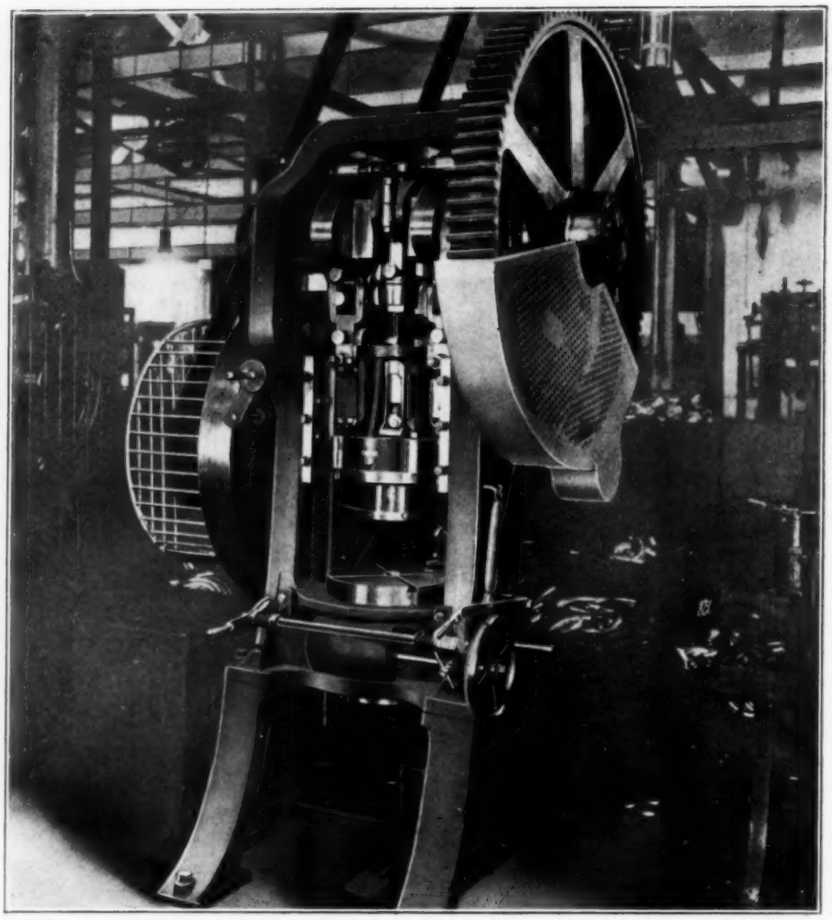


FIG. 7. SAFETY DEVICE AND GUARDS FOR A LARGE PUNCH PRESS

based on the principle of requiring both hands of the operator to be used to trip the press. Fig. 4 shows the machine stationary; Fig. 5 in the act of being tripped. The necessity of using both hands is shown plainly.

Fig. 6 shows a punch press in which the same principle is embodied, although the device is different. Here there are two levers, one on each side of the machine. One must be operated in order to remove the brake, and the other in order to throw in the clutch and thus trip the machine. This device is from the firm of Reiss & Martin, Aktiengesellschaft, Berlin.

The same principle is shown in Fig. 7, where two handles can be seen, one on either side of the press, and both must be operated in order that the press may be tripped. Another feature of this illustration is the elaborate guard around the main gear on the right-hand side of the machine and a similar guard around the belt wheel on the left-hand side. This device is from the firm of Siemens-Schuckertwerke, Charlottenburg.

Guard for the Eyes

A common accident in machine shop life is the entrance of foreign bodies into the eyes; foreign bodies such as emery grit, bits of steel, dust and the like. Guards for the eyes are shown in Fig. 8, where they are used in connection with a cutter and reamer grinder. The guard consists of a circular piece of glass, fastened into an aluminum frame and arranged with a band to attach it to the head. This is from the firm of Johannes Berg, of Kaiserslauten.

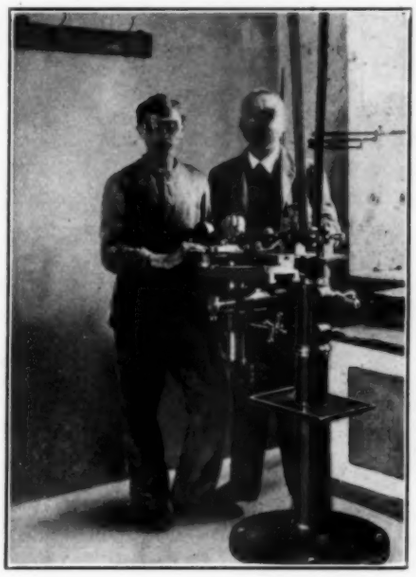


FIG. 8. GUARD FOR THE EYES

Emery-wheel Guards

While emery wheels are made with great care and very carefully inspected, still it is a fact that some of them break in use, either through excessive speed or from some accidental reason. Many of the injuries from bursting emery wheels are serious in their nature. A device intended to minimize this danger is shown by the illustrations, Figs. 9 to 12, inclusive. This is from the firm of Naxos-Union, Frankfurt a.M. It consists essentially of a steel band that surrounds the wheel. At intervals there are channel-shaped pieces fastened to the inner side of this band and intended to project along the sides of the wheel and thus catch it in case it should burst. Provision is made for adjusting this band, within limits, to the size of the wheel. At the rear of the grinder is arranged a heavy weight to be tripped by the steel band when the wheel bursts. The dropping of this weight brings it in contact with a lever, situated at the back of the machine near the base. This is connected through suitable mechanism with a clutch on the pulley shaft, and by this means the machine is stopped when the weight drops. Figs. 9 and 10 show two views of the machine with the device in place. Figs. 11 and 12 show the same device surrounding a broken emery wheel. A

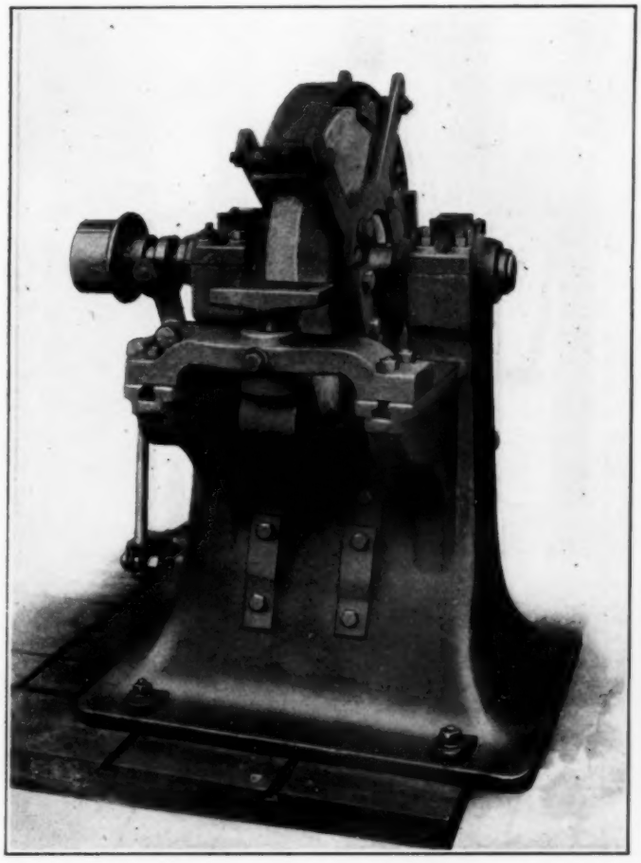


FIG. 9

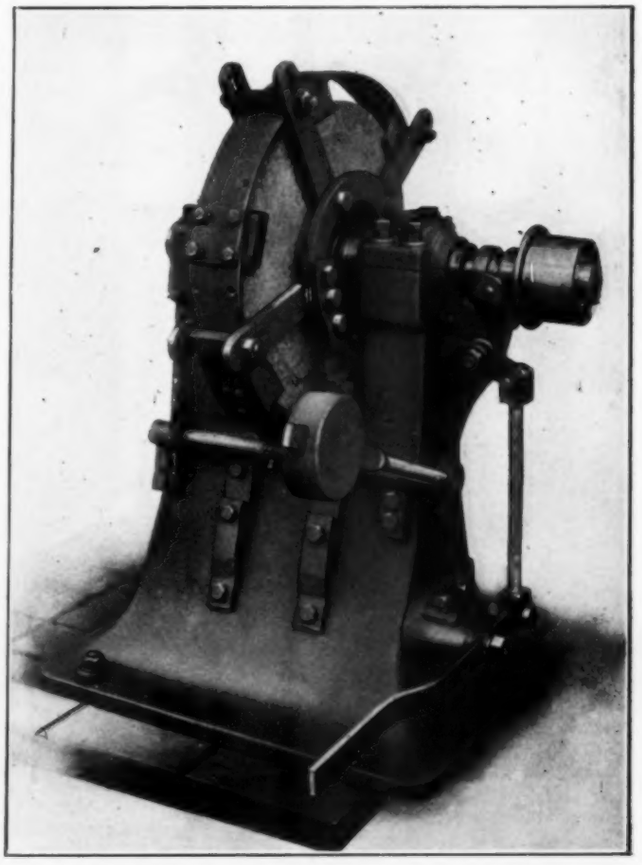


FIG. 10

AN EMERY-WHEEL GUARD

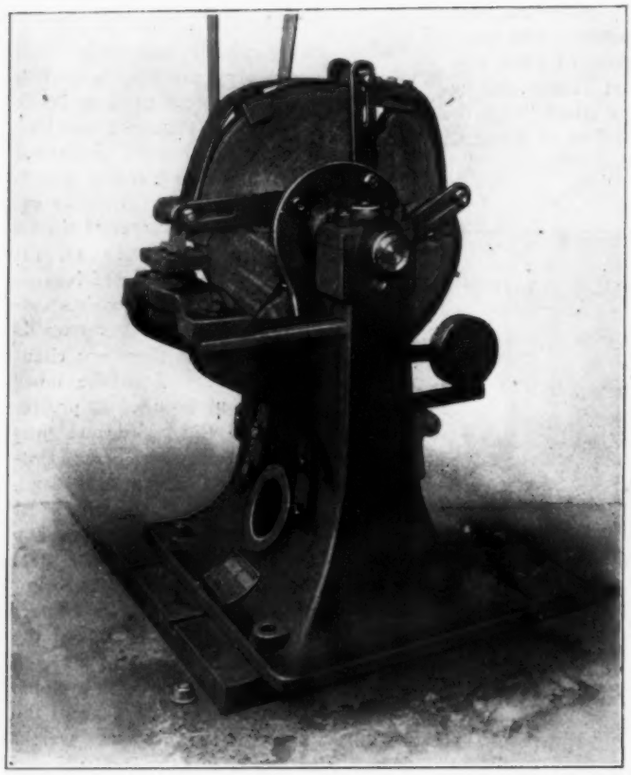


FIG. 11

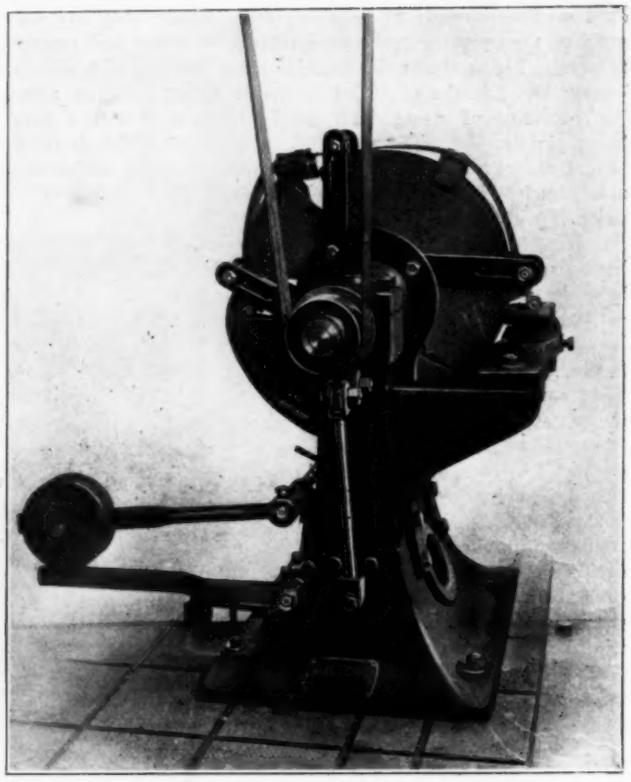


FIG. 12

AN EMERY-WHEEL GUARD THAT CAUGHT A BURSTING WHEEL

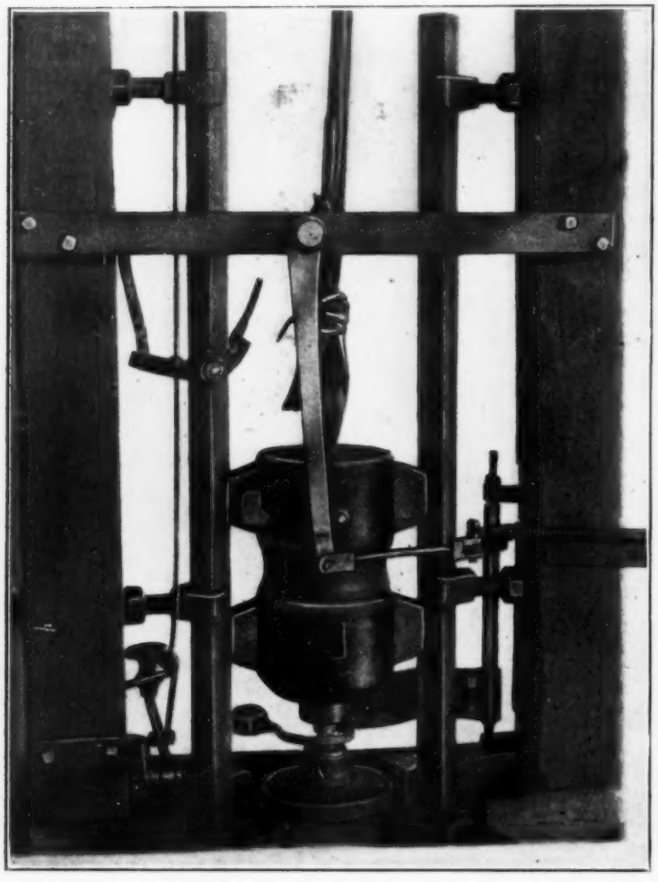


FIG. 13

FIG. 14

SAFETY DEVICE FOR A DROP HAMMER

FIG. 15.

FIG. 16

SAFETY DEVICES FOR CIRCULAR SAWS

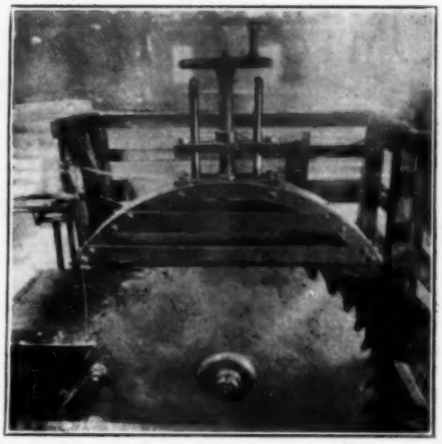


FIG. 17

note in connection with these last two figures (Figs. 11 and 12) states that the wheel was run for 8 minutes at a speed of 1260 revolutions, the equivalent of a circumferential speed of 39.56 meters per second, or say, 7250 feet per minute. During this interval the wheel was run entirely free. During the next 7 minutes it received 17 heavy blows on the side. These caused the wheel to burst into three pieces, as shown in the illustrations. The most interesting feature is the way in which the pieces of the broken wheel have been held by the steel band.

Drop-hammer Device

Figs. 13 and 14 show a protective device for a small drop hammer from the firm of Brokelmann Jager & Busse, Nehcim in Westphalia. A small lever is made to fit around the dies and is operated in such a manner that it knocks the hand of the operator away from the region of danger before the hammer descends.

Protective Devices for Circular Saws

Fig. 15 shows a protective device for a metal-cutting circular saw. This is from the factory of Siemens-Schuckertwerke, Charlottenburg. A split lever covers the saw when it is not in use. This is provided with an upward inclined end in front, so that as the work to be sawed is pushed forward the lever is raised, and the stock comes in contact with the saw. The device is very simple and appears effective for the purpose intended. Fig. 16 shows a protective device for a circular saw, consisting of a series of loosely hinged metal strips that are pushed out of the way of the work as it is advanced into the saw, and which return to their position of affording protection after the work has passed. This device is from the machine-building factory of C. L. P. Fleck & Sohnes, of Berlin. Another device for a circular saw is shown by Fig. 17. This consists of a covering cap adjustable for hight to suit the thickness for the boards or planks to be sawed. As shown the cap is lifted. This device is from the factory of Krauth & Company, of Hofen a.d. Enz.

FIG. 18. GUARDS ON A BAND SAW

Fig. 18 shows a protective device for a band saw from the same firm. It consists of a guard for the lower band wheel, a guard for the upper band wheel and saw, and an adjustable guard along the blade to prevent the fingers of the operator from coming in contact with the blade when it is in motion.

A Belt Pole

A belt pole intended to guard against accidents when snapping belts onto pulleys on the main line is illustrated by the Figs. 19 to 21, inclusive. No especial description is necessary, as the half-tones show its construction and method of use. This belt pole shows to what extent the Germans have worked out even small details in connection with factory devices in order to throw safeguards around the industrial workers.

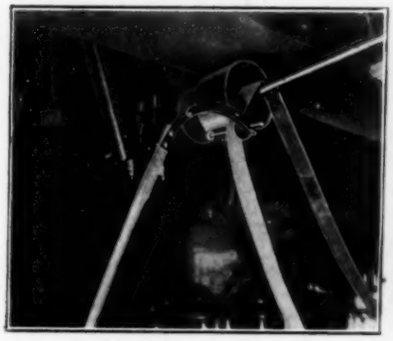


FIG. 19

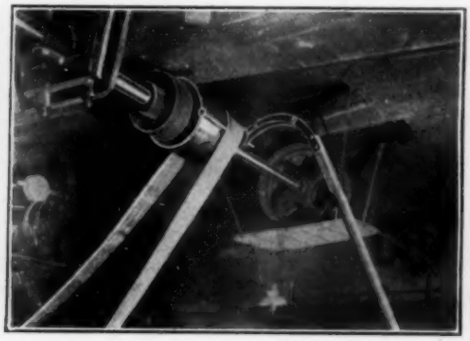


FIG. 20

A SAFETY BELT POLE

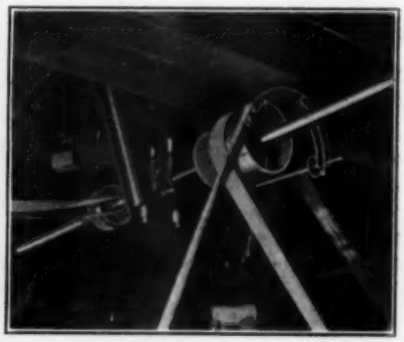


FIG. 21

Unique Plant for Blasting Castings

Defective and Broken Castings, both Iron and Steel, Are Broken into Small Pieces by the Use of Dynamite and a Huge Skull-cracker

EDITORIAL CORRESPONDENCE

Dynamite is not usually considered as a tool to be used in the working of steel and iron; yet 60-per cent. dynamite is one of the principal tools or agents used at a unique plant in western Pennsylvania. The raw material used at this plant is iron and steel in various forms and shapes; the finished product is scrap in pieces of a suitable size to be remelted. This plant is located at Hazel Kirk, Penn., about 35 miles from Pittsburg, and it is said to be the only one of its kind in the United States. The company's name is the Crescent Blasting Company, and its business is the breaking up of defective and damaged steel and iron castings and other large masses of cast iron and steel, such as skulls and furnace bottoms.

There are two sections to the plant, very similar in character and separated by a distance of about 300 yards. One of these is shown in our half-tone illustration, Fig. 1. Here can be seen two small, wooden buildings, each housing a boiler,

FIG. 2. A NICKEL-STEEL ROLLING MILL PINION WAITING TO BE BROKEN UP

FIG. 1. A STEEL AND IRON BLASTING PLANT IN WESTERN PENNSYLVANIA

winding engine and auxiliaries. Between them is located a huge skull cracker, the falling weight of which weighs 16,000 pounds, and can be lifted to have a clear drop of 76 feet. Behind the shears of this skull cracker and to the right of the derrick can be seen a low, rough structure made from logs. This is a part of the cover of a blasting pit, into which pieces are lowered that are to be treated with dynamite. Near the skull cracker is a pile of material waiting to be broken up. At the time of our visit only a small number of castings was waiting either blasting or cracking. One of them, however, is shown in Fig. 2 in the shape of a broken, nickel-steel, rolling-mill pinion, and gives an idea of some of the pieces that come to be reduced to smaller dimensions for remelting.

FIG. 3. INTERIOR OF THE BLASTING PIT

The Blasting Pit

Turning now to Fig. 3 the interior of the blasting pit can be seen. Its walls are lined with pieces of steel scrap, sections of old rails and the like. The roof is made in a large measure from old steel girders, steel rails and timbers, and is capped with a furnace bell. The floor of the pit, as shown in the illustration, is strewn with pieces of cast steel that have been broken up by blasting with dynamite. After breaking, the largest size pieces must not weigh more than 550 to 700 pounds, and, of course, many of them are very much smaller in size and weight. This picture shows the thoroughness with which the blasting operations are carried out. The general character of the fracture of the metal is also shown; the pieces are of open-hearth steel.

In blasting steel the drilled holes are spaced quite close together. These holes are 1¼ inches in diameter, and usually extend well through the piece; 1⅛-inch dynamite is used. While it is impossible to give an average number of times that a steel casting must be shot, under ordinary conditions this number will run from 10 to 20. One casting was vividly remembered by the foreman in charge, in which

FIG. 4. AN 82-TON PIECE OF OPEN-HEARTH STEEL BEING DRILLED PREPARATORY TO BLASTING

32 charges were exploded before it was fractured.

A noticeable feature of all of the holes that had been shot and could be examined was that they were very much spread at the bottom, or throughout the section where the dynamite had been placed. This feature is well shown in Fig. 5, particularly in the holes directly above the letters *A* and *B*. The original size of these holes was 1¼ inches and they show in their true size at the top of the piece. At the bottom the holes can be seen to have expanded to several times their original size before the casting actually broke; caused, of course, by the repeated stresses of the explosions. The piece there shown is of open-hearth steel, and the character of its fracture can be seen very plainly.

Cast iron, of course, breaks much more easily than cast steel. It is, therefore, necessary to drill fewer holes in a piece of similar size, and the number of shots required will average from five to eight, or probably less than half the average for steel.

FIG. 5. A LARGE PIECE OF OPEN-HEARTH STEEL SHOWING FRACTURE AND HOLES IN WHICH DYNAMITE WAS EXPLODED

An 82-ton Piece

The half-tone illustration, Fig. 4, shows an 82-ton piece of open-hearth steel resting on a freight car and being drilled preparatory to blasting. This is from a furnace bottom and is so heavy that it cannot be handled by the tackle at the plant. It is, therefore, being drilled on the car with the idea of first blasting it in that position, and thus break it into pieces which can be handled by the derrick used for lowering pieces to be blasted into the blasting pit. The type of drill is well shown, together with the method of anchoring it across the huge piece of steel. Each drill is bolted to two short pieces of steel rail, and these in turn are strapped to the underside of the car body. Power is obtained by means of rope drives from an overhead countershaft in the power house, shown in the central part of Fig. 1. It is needless to say that much of this drilling is of the hardest kind imaginable.

Echoes from the Oil Country—Ways of Hunting a Job

BY W. OSBORNE

If a man wishes to get a larger salary or to change his job for one that is more to his taste, and feels that he lacks a few of the qualifications which will help him to hold the desired position he can very readily find help. A careful look over almost any of the widely circulated publications will bring to light the fact that well organized schools are waiting, and ready, and anxious to lead his feet along in the avenues of knowledge. Even the man who has not ambition enough when let alone to want to change his condition is apt to find that there are those who wish to persuade him for his own good to join the ranks of the learned. It would seem that the man who did not acquire some of the best of useful knowledge was the exception.

Recent observation leads me to think that there is one very important branch of the tree of knowledge that the schools have very largely overlooked.

For some time back business conditions have been such that many men have been looking for work, and it does not take very extended observation to show that lots of men could well afford to pay well for a few lessons which would show them how to get the best results out of their efforts in that line. While I have never had any extended personal experience in hunting work yet I have had an extended opportunity of seeing how others do it.

Common and Unsuccessful Methods

Think how successful some of the following methods are likely to be:

The boss and a customer are talking when a man comes up. He is evidently on urgent business and in a great hurry for he pushes himself and his business at once into prominence. No, that is not quite right; he pushes himself into prominence.

"I want to see the boss." He looks at the best looking of the two men. He is looking at the customer. The customer indicates that he should look at the other man.

"Are you the boss of this shop?" The question is asked in a tone that denotes surprise and a shade of disappointment.

"What can I do for you?" asks the boss in way of reply.

"Have you been taking on any men lately." It sounded very much like the question sometimes asked by a wild-eyed man. "Have you been buying any brass lately?" Which meant that someone had been robbing his lease and he was trying to find the thief; but people do not steal men that way.

The boss considers a minute. "Is there anything else you wish to know?"

"I am looking for a job and thought that if you were taking on any men I would be willing to come to work for you."

"I have no job for you." And the boss continues the interrupted business with his customer.

One day as the boss was at work at his desk a man entered and came up and leaned over the desk where he had a good view of everything on it.

"Mr. Matthews wanted me to come and see you. You know Mr. Matthews?" Of course, the boss knew Mr. Matthews. Mr. Matthews is the heaviest operator in this part of the country. He had a small army of men working for him and his trade was well worth having, still, for the sake of the papers on the desk it might be well to find the purpose of this man's visit.

"What can we do for Mr. Matthews?"

The man twisted around a little to get a better view of a paper that had attracted his attention. As it was an advertisement of a new belt dressing it did not matter if he did read it, and so the boss restrained his natural impulse.

"Mr. Matthews is a great friend of mine. He would do anything in the world for me. I am out of work and he could not give me a job but he told me to come to you and that you would give me a job."

The boss admires Mr. Matthews' good sense in not giving this man a job and informs the man that if anything should turn up whereby he should think it to his advantage to put such a man to work he would be sure to get him word.

"I am sorry that you can't put me to

work right away, for I know that I would make a good man for you. About when would you want me to come to work?"

"You had better not count on anything here for I know that it will be a long, long time before I would put you on."

The man who comes in as this man passes out is of a different type. He is brisk and energetic.

"Say, boss, I am looking for work. Have you anything that you can give me to do?"

"What sort of a job are you looking for?"

"Anything at all. I will take any kind of a job."

The boss looks at this applicant with some curiosity. He hasn't a strictly all-round man in the place and has often wished for one.

"I could work a first-class lathe man—" he began, but was interrupted—.

"I am not a machinist, but anything else you will find me all right at."

"We might find a place for a good helper who is used to machine blacksmithing. Do you know anything about it?"

"No, really now, I never did, but I am quick to learn. I have been working in a rolling mill in Sharon, and they had me at everything there."

Further inquiry shows that this man has not even the knowledge of a machine shop that would make him a valuable man to clean out. He would not know the difference between the various kinds of chips even.

The man who came into the office and drew up a chair and sat down in it with a sigh was either sick or very tired. The boss thought that he was tired and even had a suspicion that this man had been born tired and was looking for a place to rest and not for a place to work.

Two bright-looking young fellows came in together one day. They did not get much of a show to present their case. The boss strongly objects to liquor in the shop. The breath of one of the men proclaimed aloud that he was far from being a teetotaler, while the stench of the cigarette which the other one was sucking was nauseating.

Men with Various Kinds of Testimonials

Mention has not been made of the men who bring testimonials from doctors saying that the family should be better provided for; or from preachers saying that the bearer is trying to be more nearly decent than he used to be; or from politicians saying that he is a good citizen of the party; or from the leader of the choir who wants him to sing on Sundays; or from the numerous other prominent citizens who do not know the first thing about him as a workman but who wish to pass him along so as not to be troubled.

It might be inferred that the men who seek work in some of the ways as outlined are the offscourings of the trades, but that is not the case, for they are generally well dressed and intelligent, and in many cases they are excellent workmen and give good satisfaction when they once get a foothold.

Hunting work is new to them. They never had much experience at it, and are nervous. A short course of instructions on such a subject would seem to be equally as important as to take up one telling how to hold a better job, and that is what a man studies for when he is studying to fit himself for a place which pays more money. Before a man gets the better job he has to convince someone that he will be a good man to give the job to.

How Different Men Make Applications

One morning as the boss got to the shop he found a boy standing just outside of the door.

"Are you looking for someone?" he asked the boy.

"Yes, sir. I want to see the man who does the hiring."

"I am the man. What is it."

"I am looking for work. I heard that boys work here running drill presses and other work and I thought that I might get something to do."

"Did you ever work in a machine shop?"

"No sir, but I think I can learn to do what other boys are doing. I was delivery boy for a meat market. The owner's boy has quit school and his father gave him my job. He starts in on it this morning and so I have to look for another job."

The boss has not felt the need of another boy, and that boy may turn out to be a blockhead when it comes to things mechanical, but he is back in half an hour with some overalls and has a chance to show up.

The man who took off his hat and stepped inside the door might have been a drummer. He waited until the boss turned from his desk and spoke, and then he stated his case briefly and clearly.

"I am a machinist looking for work. I have been several years at the business. I learned my trade with Smith Brothers & Co., and I prefer lathe work. I would like to get a job where I can have steady work if I can give satisfaction. This town has the reputation of being busy if any place is and if I get on I wish to move here after being here long enough to know that I suit."

If the rest of the information which that man imparts is as clear cut and to the point he gets a job if there is one for anybody.

Every man who hires workmen knows that such things are but surface indications, and that they are often misleading, yet a man has to judge by something when there are more applicants than jobs.

After many years of experience my belief is that the only way to tell what kind of a workman a man is is to put him to work and try him. Some of those who appear the most promising when applying for it turn out the most unsatisfactory, while some who are given a trial only because at the time they are the only ones at hand turn out to be valuable men in the shop. In spite of this knowledge it is the man who can make a good impression who gets the chance.

The man who comes in and demands a job with the air and tone that one could imagine a robber using in conducting a holdup may be a first-class workman when he has a job in the shop, but his way of showing it when looking for one would hardly be classed better than third rate.

Most Men Have Some Good Qualifications

Did you never know a man for a long time and think him of very little account only to find out finally that in some one direction he was away above the average?

I once had a man working for me who was a trial and a disappointment. He was honest and a hard worker but not even a club seemed to be able to get a mechanical idea into his head so as to be available. One day at noontime the fellows were talking about an entertainment given the night before and a discussion as to the pitch of the bass notes in one of the songs arose. My man who was so lame mechanically spoke with authority on the subject of music and illustrated his meaning by singing the part under discussion. I learned that he could take part in a choir and sing solos in a way that was a delight, but in the shop he was a terror from his inability to grasp things relating to mechanics.

One of the best workmen I ever knew could not write a legible hand and the rest of his education matched his writing, but he took to the work like a duck to water.

The production of bauxite in the United States in the year 1907 amounted to 97,776 pounds, the value of which represents about $480,000. Bauxite is the raw material employed in the production of metallic aluminum which constitutes its most important use. It is also utilized in the manufacture of aluminum salts, artificial abrasives, such as alundum, and in the manufacture of bauxite brick. The last use is of comparatively recent date. The bricks are of chief value in resisting the corrosive action of molten metals at high temperatures, and hence are largely used in open-hearth steel furnaces as well as in copper- and lead-refining furnaces. When subjected to the intense heat of the furnace it is converted into a solid mass of emery so hard as to be scarcely affected by steel tools, and is able to resist mechanical, calorific and chemical action.

The Premium System in a Large Jobbing Shop

A Successful Application that Brought About Great Reduction in Shop Costs—A Return to Day Work Immediately Increased These Costs

BY T. A. SPERRY

It is the purpose of this article to outline the application, installation and maintenance of the premium system in a large combined manufacturing and jobbing machine shop; to give some of the results of this application, and to show the almost immediate fluctuation of the time elements of doing work when the incentive of premium is removed. The location and name of the particular plant in question is not pertinent to the discussion, except to say that it is situated in the outskirts of a large city in which the supply of skilled labor in this line is not good or adequate; it is necessary, therefore, to employ a large proportion of second-class and rapidly changing help, and make the best of them. A few of these men will stay by, however, and gradually develop into very efficient and skilful men in their particular line of work.

When running normally the plant employs nearly 2000 men in all departments; these departments include a machine shop, forge and smith shop, gray-iron foundry, pipe foundry, boiler shop, structural-iron shop, screw department and an ornamental-iron department. Each of these shops or departments is in a separate building and all of them, except the pipe foundry and ornamental-iron department, are conducted in large part under the premium system. Yard labor also, to a certain extent, is placed on the same basis.

The character of the work in most of the departments is sufficiently indicated by the name of the department, except to say that the variety of work is large and the manufacturing quantities generally comparatively small; it is the general policy of the firm to build almost any article, or articles of any type or size that a customer wants and will pay for. In the machine shop, especially, the variety is very large, comprising in the main, locomotives (any size or type), steam shovels, derrick cars, air compressors, more than one hundred varieties and sizes of pumps, electric locomotives, gas engines, gas producers, rock crushers, small steam engines, street-car trucks, valves, hydrants, air brakes, steam traps, etc.; besides a great many special orders and parts, most of these built to customers' orders and largely in small lots. Altogether, it looked about as unpromising a field and as difficult a problem for any sort of system work or premium work, as one is apt to encounter in machinery manufacturing shops. That such an installation could be, and was made a success, however, is decidedly shown by the results obtained. The most difficult part of the problem by far was found to be in the machine shop, so a description of the work here will be sufficient to cover all of the departments.

Premium System Organization in the Machine Shop

The organization as finally perfected, so far as the scope of this article is concerned, consisted of a production department, a premium and routing department, and a cost department, with shop time takers, besides the usual military type of organization in the shop itself. Each of these departments was entirely independent of the others; each had a separate head reporting directly to the management proper, yet each worked harmoniously with, and more or less dependent on, each of the others.

The engineering department transmitted each order, with a full detailed list of parts, drawings, special instructions, etc., to the production department as soon as the order was ready for the shop. The production department would then assign the necessary shop-order number, make the necessary distributions of the various parts to the various shops, issue orders to the shops for these parts, etc., and would then fill out on a typewriter from the lists of material required—see the upper portion of the master card Form I. This card (5x8 inches) is self explanatory except to say that the "Guide No." is the production office's record number for the card, and the line "Time required to make," etc.. is intended for orders where the parts are carried in stock. One, and one only, of these cards is filled out for each and every distinct pattern or piece made, and is used for that piece every time it is made, regardless of shop-order number or purpose for which it is intended. The back of the card is used as a stock and progress record, but is not pertinent to this discussion.

After the upper part of card is filled out by the production department, the cards are sent to the premium and routing department which immediately analyzes the work and decides, in conjunction with the shop or other departments if necessary, the best way of handling the work in the shop, etc., and routes the piece, under

MASTER CARD

GUIDE No.

NAME OF PART.....

SIZE.....

TIME REQUIRED TO MAKE ..... MFG. QUANTITY..... MINIMUM STOCK .....

MATERIAL	AVERAGE WEIGHT	PATTERN NO.	DRAWING	LIST	REMARKS ON ANY CHANGES

OPERATIONS	DEPT.	MACH.	PREMIUM ALLOWANCE	ORDERS SENT TO MILL OR FOUNDRY					
				DATE	S.O.	QUANTITY	DATE	RECEIVED	REMARKS
1									
2									
3									
4									

FORM I. MASTER CARD

FOREMAN MUST SEE THAT TAG IS ATTACHED TO WORK WHEN MOVED.

SHOP ORDER..... NO.....

NAME OF PART.....

MATERIAL..... SIZE.....

DRAWING..... LIST..... PATTERN.....

DATE MATERIAL WANTED.....

DATE TO BE FINISHED.....

DATE FINISHED AND SENT TO STOCK.....

OPERATIONS	DEPT.	MACH.	PREMIUM
1ST			
2ND			
3RD			
4TH			
5TH			
6TH			
7TH			
8TH			
9TH			
10TH			
11TH			
12TH			
13TH			
14TH			
15TH			

Workman must hang this tag in a conspicuous place when engaged on this job, and must attach it to work when his operation is finished.

MATERIAL RECEIPT

SHOP ORDER..... NO.....

NAME OF PART.....

SIZE.....

DRAWING..... LIST..... PATTERN.....

DATE MATERIAL SENT TO SHOP.....

WEIGHT..... COST OF MATERIAL.....

FOREMAN

THIS RECEIPT TO BE RETURNED TO PRODUCTION DEPARTMENT.

FORM 2. WORK TAG

"Operations," etc., accordingly, giving department and sub-department and, if advisable, the machine (number) in which the operation is to be done. If premium limits have previously been established or are decided upon while routing the piece, these are entered in their proper place, and the card returned at once to the production department. As new limits are established, they are reported and entered on this card.

The production department immediately fills out the shop order tag, Form 2, from this master card (subsequent tags are filled out as often as required), and sends these direct to the stock movers (a function of the routing department) who immediately attach the tag to the castings or parts and deliver them to the portion of the shop where the first operation is to be performed. The material-receipt stub is signed by the foreman of this department, and is then sent by the stock movers to the production department as a notification that the material is in the shop, and also giving its weight for the cost-department work.

These tags (4x8 inches, or 4x6 inches without stub) are regarded almost as sacred; each one must be accounted for to the production department when the work is reported finished; the return of the tag is the official notification to the production and cost departments that the work is finished. The timetakers' daily reports to these departments of operations finished allow both departments to keep in absolute touch with the progress of the work through the shop, and the cost of the work by operations or total, within one day of the time the work on each operation is done. No material or work is allowed in the shop unless accompanied by the proper tag, and no work is performed on any piece unless specifically called for on the tag. It is understood, however, that any operation or routing may be changed at any time for a suitable reason by making a request to the routing department. When an operation is changed the routing department must at once notify the production and cost departments so that their records may be altered in accordance.

RECORD AND CONDITIONS FOR PREMIUM STANDARDS. RECORD No.

PATT. No. DRAWING LIST DEPT. OBSERVER DATE

OPERATION DETAIL

MATERIAL NATURE

NAME OF PIECE SIZE FOR

MACHINE No. CONDITION

JIGS FIXTURES

TOOLS AND EQUIPMENT

WORKMAN CHECK No. RATE CLASS

OPERATION	ROUGHING				FINISHING								LOT	
	SPEED	FEED	DEPTH	NO. CUTS	SPEED	FEED	DEPTH	NO. CUTS					NO. PCS.	NO. OBS.
OBSERVED														
ESTIMATED														
TIME	SETTING MACHINE	GETTING TOOLS	SETTING WORK		ROUGHING	FINISHING		REMOVIN.					PER	TOTAL EACH
TIME CARD														
OBSERVED														
ESTIMATED														
ALLOWED														

REMARKS

TIME LIMIT SET	APPROVED	DATE	RECORDED	DATE	PREM. CARD No.	(SKETCH—NOTES ON OTHER SIDE) SUPT. STD. OP.	DATE

FORM 3. RECORD AND CONDITION CARD

THE PREMIUM DEPARTMENT

So much for what may well be called an introduction to show the interrelation of the departments. To come now to

Name of Part.	Operation.	Day Work, Hours Each.	Premium Limit, Hours Each.	Premium Work, Hours Each.	Total Cost Each Piece. Hours.		Per Cent. Decrease of Cost on Premium.	Per Cent. Increase of Wages on Premium.
					Day Work.	Prem. Work.		
Side frames	Plane complete	55	26	14	137½	41	70	43
Side frames	Slot complete	47	22½	10	117½	31½	73	63
Side frames	Drill and tap	46	20	13	115	36	68	27
Frame guards	Plane complete	4½	1½	¾	10⅜	2½	76	36
Track side frame	Slot complete	7	2½	1½	17½	3⅜	80	40
Track side frame	Drill	5	1½	1	12½	2⅜	78	25
Steam cylinder	Bore and face	30	9	4½	75	14	81	45
Steam cylinder	Bore and face for valve	25	9	5½	62½	15½	75	32
Steam cylinder	Plane	13	7	4	32½	11½	65	38
Steam cylinder front head	Turn, bore and face	7½	2¾	2	18⅜	5⅜	71	19
Steam cylinder back head	Turn, bore and face	13	6	4½	32½	11½	65	21
Steam cylinder back head	Drill and tap	3½	1½	¾	8⅜	2⅜	75	50
Crosshead	Plane complete	23	10	6	57½	17	70	33
Crosshead	Bore and face	19	7	4½	47½	13½	72	28
Crosshead guide bar	1st Plane	9	4½	3½	22½	8⅜	64	20
Crosshead guide bar	2d plane	2	1¼	¾	5	2⅜	57	33
Crosshead guide bar	Plane taper	8	4	2½	20	7	65	30
Crosshead guide bar	Drill for frame	30/1000	30/1000	30/1000	1½	¾	73	33
Main side rod	Plane	7	3	1½	17½	4½	74	50
Main side rod	Mill and flute	36	15	7	90	21½	76	57½
Main side rod	Chip keyway	4	1¾	1	10	2½	71	38
Main side rod	Assemble	162	40	22	405	64	84	41
Drive wheel centers	Air chip	6	3	½	15	4½	70	50
Drive wheel centers	Turn, bore and face	23	9	4½	57½	14	76	45
Drive wheel centers	Slot keyway	4	1½	1	10	2⅜	72	25
Drive wheel tires	Bore	3	1	41/1000	7½	1¼	82	70
Drive wheel tires	Turn, after assemble	22	5	3½	55	9	84	27
Drive-wheel axles	Turn, and roll	10	4	3	25	8	68	33
Drive-wheel axles	Press on wheel	4½	¾	½	11½	1½	87	50
Foundation ring	Plane top and sides	16	8	5	40	14	65	30
Foundation ring	Slot end and corners	42	20	8	105	26	75	75
Foundation ring	Plane inside	11	5	2¾	27½	8	71	41
Reverse quadrant	Plane, two sides	4	2½	1½	10	4⅛	58	33
Reverse quadrant	Bore and turn	2½	¾	¼	6¼	¾	88	50
Reverse quadrant	Cut notches	6	1½	1	15	2⅛	81	38
Valve rod	Turn, bore and face	11	6	4½	32½	12	63	17
Valve rod coupling	Face, two sides	3	1½	1	7½	2⅛	62	38
Reverse shaft	Bore and face arms	8	2½	1½	20	4⅛	79	33
Reverse shaft	Turn and face	20	8	3	50	10	80	83
Guide yoke	Slot complete	20	8	5	50	14	72	30
Eccentric rod	Plane, two sides	5½	2¼	1½	13⅜	4⅜	68	42
Eccentric rod	Slot jaws	4½	1¾	1¼	11¼	3⅜	70	20
Engine truck	Assemble	176	22	13	440	37	91	35
Tender truck	Assemble	124	30	18	310	45	85	33
Tender truck axle	Turn and roll	15	5	3	37½	8½	77	33
Internal drive axle	Turn and roll	13	6	3	32½	9	72	50
Internal drive axle	Mill keyway	4½	1½	½	10⅜	1½	87	75

TABLE 1. RECORDS OF MACHINE WORK ON PARTS OF 19 INCH BY 26 INCH LOCOMOTIVES SHOWING REDUCTION OF TIME AND INCREASE OF WAGES UNDER PREMIUM PLAN.

the specific work of the premium department: This department in conjunction with the routing was placed in the charge of a man with a wide shop experience, who had made an intense study of the time element of doing work, modern shop methods, premium and demonstration work, etc. He was given all necessary assistance and support by the shop and management. The force for the combined department consisted of one routing clerk, one office or records clerk, one time-study man in the shop, one demonstrator, a stock mover, and three or four helpers, an office boy, and the coöperation of the timetakers. With this force, some 14,000 limits were set and established as the result of two years' work. Not bad in view of the unsettled shop conditions, and the great amount of supplementary work accomplished!

With conditions as outlined above and in view of the jobbing nature of the work, it was found inadvisable, if not impracticable, to place the entire shop and work on a standard operation basis before beginning to establish time limits, as would be done in a purely manufacturing plant. It was also found best not to attempt to establish limits on all parts or operations of any one machine or certain class of parts of machines, nor on any particular line of machine work; but instead, limits were established, first, on the more important or prominent operations of such pieces or lots as were best adapted for time-limit work as the pieces were going through the shop. For example, one limit would be set for boring and facing a locomotive cylinder, and the next one might be for assembling a 6-inch standard gate valve, or forging a lot of structural bolts. It was found necessary to be very explicit in stating and recording the exact work covered by each limit and also the exact conditions under which and by which the work was performed. In the great majority of cases the same work, or a very similar piece of work would have to be performed again later on, and shop conditions and environment were changing rapidly. A great many of these changes would necessarily involve a change of time limit.

Records and Conditions Card

For the purpose of keeping these records a records and conditions card, Form 3, was designed. As will be seen, this card (5x8 inches) is very complete, and covers the entire history of the operation and the setting of the limit, pattern, drawing and list numbers (several pieces being usually shown on each drawing and each designated by a list number); the department in which the work is done (numbers being used for departments and sub-departments); the name of party (observer) by whom and date on which the card record is made; the standard name of the operation (which should either correspond with, or be a subdivision of the operations as routed on the master card and routing tag) and a detailed statement of the actual work involved in, or covered by the operation; the kind and nature (hard, soft, sandy, etc.) of the material used; the official name of the part (to correspond with drawing name) with its size and for what machine or purpose used; the machine (number) on which the work is done and its condition as to repair, adaptability to the job, etc.; what jigs and fixtures are used for the operation (these should preferably all be numbered); what tools used (tools should all be ground to some definite standard of form, and may then be described simply as "Novo standard," "A. W. standard," or whatever they may be, and any other than standard tools added to the description); the workman's name, check number, wage rate (if advisable) and class (machinist, apprentice, handyman, etc.). So far the record may be said to cover preliminary data only.

If now the record is made from the actual observation of the work as it is being done in the shop, entries of observed or demonstrated speeds, feeds, etc., for the various cuts may be made under the heading, "Observed," and under the paragraph, "Time," and heading, "Observed," the time elements for the various phases of the operation, carrying the total time to the end of the card, where total time for any number of pieces and also for each piece are recorded, the total

PREMIUM STANDARDS. CARD NO.

NAME OF PIECE		TYPE AND SIZE OF MACHINE			
PATTERN OR PIECE NO.	DRAWING NO.	LIST NO.			
OPERATIONS		TIME LIMIT	DEPT.	DATE	NOTE

FORM 4. PREMIUM STANDARDS CARD

Name of Part.	Operation.	Premium Work. Premium Work, Hours Each.	Premium Work. Burden, Hours Each.	Premium Work. Premium Paid, Hours Each.	Premium Work. Total Cost, Hours Each.	Day Work. Day Work, Hours Each.	Day Work. Burden, Hours Each.	Day Work. Total Cost, Hours Each.	Per Cent. Increase of Cost on Day Work.	Per Cent. Gain of Wages on Premium Work.
Side frame	Plane complete	14	21	6	41	38	57	95	132	43
Side frame	Slot complete	14½	21¾	3½	39¼	21½	32¼	53¾	36	27
Side frame	Drilling rim and spot	7½	10½	1½	19½	9½	14¼	23¾	22	19
Steam cylinder	Bore and face	5½	8¼	1¼	15	8¼	13¼	21¼	41	32
Steam cylinder	Plane	9	13½	2	24½	12	18	30	22½	22
Steam cylinder	Drilling tap and spot	18	27	3½	48½	27	40½	67½	39	19½
Steam cylinder back head	Turn, bore and face	4½	6¾	¾	11¾	7½	11¼	18¾	65	17½
Steam cylinder back head	Plane	¾	1¼	¼	2¼	1¼	2¼	4¼	106	33
Steam cylinder back head	Drill and tap	¾	1¼	¼	2¼	1¼	2¼	3¼	67	50
Forward frames	1st plane	2	3	½	5½	3½	5½	8¾	66	12½
Forward frames	Drill and face	2¼	3 5/16	¼	6 5/16	3¼	5¼	8¼	33	26½
Drive-wheel centers	Turn, bore and face	7	10½	3	20½	11	16½	27½	34	43
Drive-wheel centers	Drill for rectangular ring	1½	1½	½	3¾	2½	3¾	6¼	85	20
Drive-wheel centers	Bore for center pin	2	3	1½	6½	3	4½	7½	15½	75
Drive-wheel centers	Drive and tap for plugs	1	1½	½	2¾	1½	2¼	3¾	30½	39
Drive-wheel tires	Bore and face	3	4½	½	8	5	7½	12½	56	17
Drive-wheel tires	Turn and face (pair)	6	9	2½	17½	12	18	30	71½	42
Side rods	Plane ends	1¼	2¾	¼	4¼	3½	4¾	8¼	71	22
Side rods	Drilling tap and face oil cups	3	4½	½	8	4	6	10	25	17
Side rods	Mill sides	¾	1½	¼	2¼	2¼	4¾	6¾	212	33
Eccentric rod	Slot	1½	1½	¼	3¾	2½	3¾	6¼	85	20
Eccentric rod	Drilling and rim, 4 holes	1/16	1/16	1/16	1⅛	9/16	1 7/16	2½	104	25
Guide bar	Plane complete	2½	3¾	¼	6¾	3½	5½	9¼	47	33
Guide bar	Drill and spot	¼	¼	¼	¾	¼	1 1/16	2 5/16	46	50
Spring hanger	Drilling rim and center bore	¾	¾	¼	1¾	¾	1½	1½	36	25
Spring hanger	Slot	5/16	15/16	1/16	1 5/16	½	¾	1¼	50½	26½
Tender truck	Assemble	20	30	5	55	32	48	80	45½	25
Engine truck	Assemble	13	19½	4½	37	21	31½	52½	42	34½

TABLE 2. COMPARISON OF MACHINE WORK ON PARTS FOR 18 INCH BY 24 INCH LOCOMOTIVES SHOWING EFFECTS OF REMOVING PREMIUM LIMITS.

number of pieces in the lot and the number on which observations are made is recorded under heading "Lot" above.

If the data are obtained by estimation from drawings, etc., they are recorded as above except that they will be placed under heading, "Estimated," instead of "Observed." If data are taken from timetakers or cost-department records, it is recorded (totals only generally) under heading, "Time Card," and, of course, no speed and feed record made out. If data are obtained on any other basis, as, for example, by conference with foremen, it is recorded under heading, "Allowed." The card thus provides an excellent means for comparing results arrived at by the different methods usually employed in time setting. The time limit allowed or set for the operation is then recorded; the initials and date of approval of this limit by the shop superintendent (if deemed necessary); the initials and date of the record clerk by whom the limit is transferred to the premium standards card, Form 4, and also number of the premium standard card to which the record is transferred; the initials and date of the official adoption by the superintendent of standard operation (premium) department, completes the record in full. It is often desirable, however, to make a freehand sketch of the work or portion of the work covered by the operation, or to make additional notes or detailed observations of the operation, and the back of the card is reserved for this purpose. When so used a check mark should be placed opposite "sketch notes on other side."

PREMIUM DEPARTMENT RECORD OF WORK DONE.

Date _____

EMPLOYE'S NAME		CHECK	DEPT.
PAT. No.	DRAWING	LIST	SHOP ORDER
NAME OF PIECE		FOR	
OPERATION			MACHINE No.
No. PCS. FINISHED	TIME LIMIT EACH		TOTAL LIMIT
TIME TAKEN	TIME GAINED		TIME LOST
PREMIUM EARNED	TO BE PAID		

FORM 5. (A) (B) (C) PREMIUM DEPARTMENT RECORD OF WORK DONE

A complete record on this card should be made in from three to fifteen minutes, except, of course, for prolonged observations of operations, according to the complexity of the work and the difficulty of obtaining the necessary data. For a shop of the character described, a file of these cards carefully filled out makes an almost invaluable record worth many times its cost. When two men can establish 14,000 such records in two years, the cost is not great.

Other Forms

As the limits are established on Form 3, the Records Clerk transfers them at once to the premium standards card, Form 4, (4x6 inches). One of these cards is made out for each and every different pattern or piece manufactured. The records clerk makes the copy from the master card, Form 1, after these have been routed, with the operations corresponding to the master card. This card must show every limit established for the piece. The workman knows from the routing tag whether or not there is a premium limit for their operation on the various pieces; if not, the timetakers immediately request the premium department to supply a limit for the job. The timetakers, by the way, should be men who have had considerable experience in shop work and who know what they are doing. Accuracy of cost work and all records depend on the timetakers, and they will prevent all "juggling" of time reports so prevalent where workmen keep their own time. A good timetaker should care for 100 men, generally, and as it takes the average machinist ordinarily ten minutes a day to make out his own time, it will cost less than one-half the wages thus lost to employ a good timetaker.

As soon as a job is finished, the time taker (or sometimes the records clerk) makes out Form 5 in triplicate (these are padded so that carbons may be used). Form 5 (a) is retained in the premium office as a time record of the operation (with notes on blank space at bottom if desirable). Form 5 (b) is given to the workman as his record of the work, and as a guarantee of good faith to the firm. Form 5 (c) is given to the foreman so that he may know how his work is going.

Form 6 is in the nature of a comparative or supplementary device to aid in setting limits on pieces of which there are several sizes, as, say, gear blanks, in use in the various products manufactured. A freehand sketch of one of these pieces is made on one (sketch) side of the card; letters are used in place of dimensions. On the other side of the card are entered the sizes corresponding to these lettered dimensions for all sizes or pieces of similar parts, giving with each the drawing, list and pattern numbers from which dimensions were taken. After limits have been established on one or two sizes of these parts, it is very easy to determine the corresponding proper limit for any other size or sizes of similar parts by comparison or interpolation.

In these forms and devices an effort has been made to make them as universal and as comprehensive as is possible; they will be found applicable with very little or no modification to almost any machinery, manufacturing or building works. It must be borne in mind, however, that "forms," as such, are valueless; it is only as they serve as a means to a certain, definite end that importance attaches to them. No set of forms has ever yet been devised which is absolutely automatic and fool-proof in its application; the personal element behind the work, here as in all other fields, is what must and will determine the value and efficiency of the results obtained.

Comparison of Premium and Day-work Results

Table 1 shows, by a few actual examples taken almost at random from several thousand cases which might have been selected, the results of placing the premium system in this particular shop, under the conditions previously stated. The table is made up entirely from locomotive work, for no other reason than that this work is probably more widely known and more nearly uniform in design than other lines of manufacture. As will be explained later, it makes a stronger comparison with Table 2. The records for Table 1 are made from a 19x26-inch 2-8-0-176 locomotive (19-inch cylinder, 26-inch stroke, 2 engine truck wheels, 8 driving wheels, 0 trailing drivers, 176 tons weight). Table 2 is from an 18x24-4-4-0-122 locomotive.

Table 1 shows the average number of hours per piece taken to complete the various operations shown when working day work; the premium limit which was established for the operation; the number of hours per piece in which the workmen finally accomplished the task; the cost, in hours per piece, including the shop burden figured at 150 per cent. of the working time, of the operation for both day work and premium work; the percentage of decrease of cost per piece of the premium work under the day-work cost; and the percentage of increase of wages per hour made by the workmen while on each operation. For the examples given in this table, the percentage of decrease of cost varies from 57 to 91 per cent., while the increase of wages is from 17 to 83 per cent. for the various operations. These figures are representative, but do not cover extreme cases, as the cost of a few pieces was decreased by only 15 or 20 per cent., while the workman's gains varied from 0 to over 100 per cent. in a few cases. It is safe to say that the average decrease in cost was 50 per cent., while the average increase in wages was 20 or 25 per cent.

When the recent financial stringency curtailed orders and necessitated the reducing of the shop forces, the premium system was kept in force until practically all orders except one lot of locomotives had been completed. It was then decided to recall the premium system from the shops until work was again resumed in its normal condition. Meanwhile every effort was made to keep the time rate of doing work on this lot of locomotives and such other little work as was available, to its existing standard as set under the premium system. The results are shown in Table 2, all day-work observations of which were made within one month of the date on which the premium was recalled. All work and time were carefully watched; the men were urged, exhorted, and cajoled, and a few of them made examples of for failing to make the previous time limits on their work. Yet, as will be seen, on work on which the men had been making an increase in their wages of from 12 to 75 per cent., the cost per piece for the operations shown almost immediately increased by from 15 to 132 per cent.

It must not be inferred that all the decreases of cost shown in Table 1 are due entirely to the premium inducements, as the general intensifying of conditions and gradual improvement of environment and facilities would of itself have reduced, to a certain extent, the machinery time and consequently the cost of the work. Also in Table 2 it may safely be argued that a certain part of the increase of the working time (and so of the cost) was due to the general slackness of work in sight, which no amount of inducement or cajoling can overcome. It is a well established principle of shop practice that a workman will not work himself out of a job if he can help it, yet the evidence is so strong, and the changes so instantaneous, that by far the greater portion of the improvement shown must be attributed directly to the operation and influence of the premium system.

NAME OF PIECE MACHINE AND TYPE

SIZE	DRAWING	LIST	PATTERN	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O

SKETCH FROM DRAWING NO. MATERIAL DATE

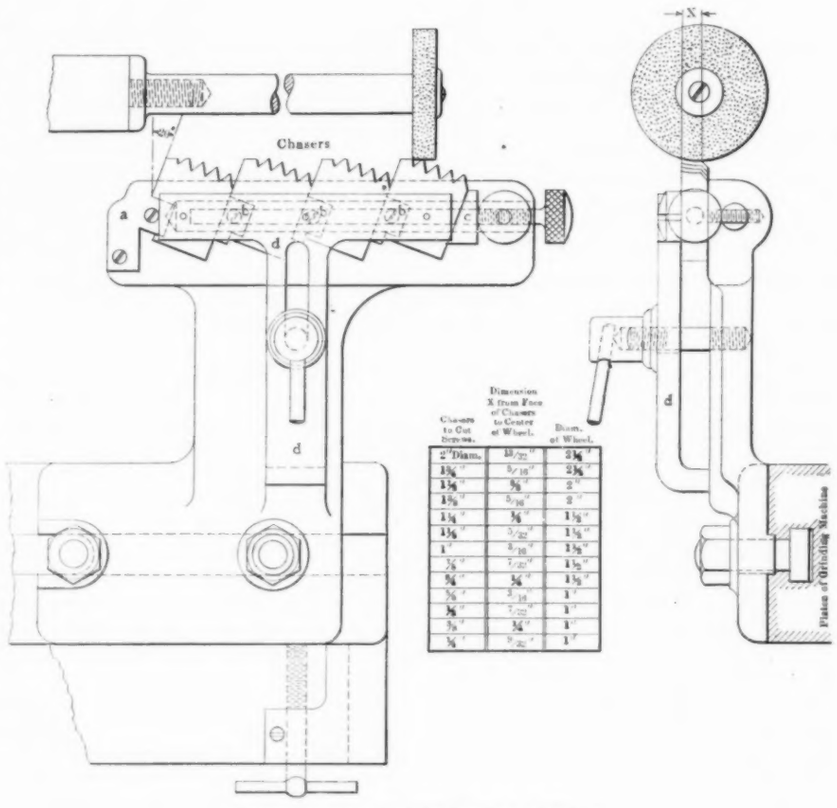
NOTES

FORM 6. SUPPLEMENTARY RECORD CARD—FRONT AND BACK

Chaser Grinding Attachment

By Isaac Morgan

Every user of automatic die heads knows that where the chasers are ground in the throat it is very important that all chasers in a set should be ground exactly alike in order that each do its share of the work, and that they should be ground as slightly as possible to the end that the life of the chasers be prolonged. Many fixtures have been devised and some machines have been specially built to accomplish this object. Some of these have the holder arranged to hold only one chaser, which seems to me a defect inasmuch as some one of a set of chasers will always need more grinding than its mates, so that it will often be necessary to replace them on the grinder in order to take off just a little more. The fixture here shown is designed to receive a full set of chasers which are ground at a single operation, each one resting against a block exactly as it does in the die head. The first of these blocks *a* is solidly fixed at an angle of 20 degrees; the other blocks *b b b* are free to slide on a tongue in a slot in the extension plates and take their positions according to the thickness of preceding chaser and assume the same angular position as the fixed block, being forced against it by pressure of the screw in distance piece *c* which also has a tongue to fit the slot and prevent its sliding out of position. This block *c* is longer to accommodate smaller chasers. The machine is shown set up for large size chasers of the Hartness die head and as the small sizes are each ¼ inch smaller, we simply have the distance piece *c* 1 inch wider. The clamp *d* to hold the chasers in place has a leather face to secure tension on all chasers. This fixture as shown is an attachment to a regular grinding machine having platen movements in all directions.



Chasers to Cut Screws.	Dimension X from Face of Chasers to Center of Wheel.	Diam. of Wheel.
2" Diam.	15/32"	2¾"
1¾"	5/16"	2⅜"
1½"	5/16"	2"
1⅜"	5/16"	2"
1¼"	5/16"	1½"
1⅛"	5/32"	1½"
1"	5/16"	1½"
⅞"	7/32"	1½"
¾"	5/16"	1½"
⅝"	5/16"	1"
½"	5/16"	1"
⅜"	7/32"	1"
⅞"	¼"	1"
¼"	7/32"	1"

GRINDING ATTACHMENT FOR DIE CHASERS

The chart showing hight to set chasers above center of emery wheel and size of wheel to use has never been worked out on a scientific basis, but in practice gives good results.

Trade School Conditions in Europe

By John M. Shrigley*

The practicability of teaching trades in schools is not a new idea in Europe. In John Evelyn's diary he notes in 1641 visiting a school in Amsterdam where several occupations were taught, and the philanthropist, Abbe de St. Pierre (1658-1743), was an earnest advocate of such institutions and established one or more in France.

The practical development of the thought has, however, been quite slow, and not much progress was made until the latter part of the last century. The introduction in 1868 in the engineering school at Moscow of the "Russian" method of systematic class instruction, marked an epoch in the matter, and gave a great impetus to it. Even today, however, there are not nearly as many trade schools, in the broad sense of the term, in Europe as there are generally supposed to be. I mean such schools as give complete apprenticeships in *themselves*, with a proper collateral academic training.

One of the earlier efforts was the school of horology in Geneva, Switzerland, which was founded in 1824, and which has developed into a commendable institution, with thorough courses in the various details of watchmaking, and with excellent instruction in mathematics, mechanics, trade drawing, etc. It is located in a good part of the city and in a commodious, well equipped building. The admission age is from 14 to 17 years, and the course averages about four years of 48 weeks each. There is a moderate charge for its benefits. I mention this as a good type of its class. On the other hand, a visit to a school of cabinetmaking in a large German city showed a dismal failure. It merely produced cheap furniture, the finishing touches being put on by teachers and journeymen. The superintendent pointed with pride to the best feature of the place, viz., a well seasoned stock of American poplar plank!

There are other schools in Germany and Austria where a limited school training is given in winter in some of the building trades, the rest of the year being devoted by the apprentices to their masters' service.

France is now bestowing considerable attention on the development of schools in which are given the theory and practice of trade work, as well as a fair general education.

The Franco-British exposition held in London last year had a large exhibit of the work of these schools especially in machine work and patternmaking. The examples were on instructional graded lines and looked well. Many fine large photographs of the schools showed attractive buildings with excellent equipment.

Belgium and Holland have some schools on similar lines, and their graduates are considered very desirable mechanics. Italy, Denmark, Sweden and Norway are doing almost nothing in the line of trade instruction, though the subject is being agitated especially among those interested in the technical high schools of these countries. In Trondhjem, Norway, a school of carpentering is to be started this year, and there is in that little city a commendable school which, between fishing seasons, gives to seamen, mates and captains a scientific course in navigation.

Great Britain seems to be in the rear rank of manufacturing nations in school-trade training for apprentices, the employers clinging close to the old methods. Indeed a society has been recently founded in London to induce boys to apprentice themselves to masters. It had a department in the Franco-British exposition in which a very few very small boys were working on locks and tinware. There are also on the continent some schools, mainly in evening session, for giving or improving technical knowledge to journeymen and foremen. The instruction in them comprises drawing, design, mathematics, physics, chemistry, bookkeeping, composition, etc. Then there are the technical high schools generally well housed and equipped, having excellent courses leading to engineering, architecture, etc. Their designation is a little confusing as they are really colleges, the mechanical instruction being only supplementary to the professional courses.

We now reach the type of schools of which we hear the most, viz., the "Continuation Trade or Vocational Schools." In Munich such schools have reached their highest development largely through the efforts of Dr. George Kerschensteiner, their superintendent, who is generally considered the leading German authority in this department of education. Nearly 50 trades and vocations are included in the curriculum of the Munich schools. As a rule they are not trade schools as defined in the beginning of this article, the time spent in them being quite limited. For instance, it is 7½ hours per week for the stone and brick mason, and the carpenter; 9 hours for the lockmaker and the joiner; 10 hours for the machinist, etc., most of the apprentice's time being spent in the service of his employer. The school attendance is obligatory. The efficiency of instructional school training has been found to be so great, however, that there is an earnest disposition to lessen the factory and increase the school time, some hoping that the day will arrive when social and financial conditions will permit placing the entire responsibility on the schools. Doctor Kerschensteiner's thought on the subject was expressed by saying to the writer: "A shop or factory cannot produce a good mechanic. Nearly all of them lack sufficient variety in scope of range and quality of work to enable them to do so. Furthermore, many of them are not prepared to impart to their apprentices what they know themselves."

The disposition to enlarge the province of the schools is shown by the fact that a few of the trades are allotted 36 to 48 hours' school instruction per week, notably artistic forging and lockmaking. Most of the European schools have excellent technical libraries, and good museums of the materials used, as well as the educational products. The buildings of the Munich continuation schools are particularly commendable. Social conditions in many parts of Continental Europe greatly favor trade education. Parents desire to have their children given vocational training, and they, as well as their boys and girls, welcome any opportunities offered in that direction. The governments, national and local, are warmly interested in the furtherance of the matter, realizing that it makes for the public "good" and thereby enhances the prosperity of their communities and their countries. The employers, the guilds, and mechanics are generally firm believers in its beneficial advantages to them and their respective trades.

When these conditions are instilled into our American thought and life, as they will be sooner or later, the result will be a general scheme of trade education in the United States which will lead the world.

*President, Williamson Free School of Mechanical Trades.

Many kinds of cheap woods, which ordinarily would soon decay if set in the ground, can be made to last for twenty years by a simple treatment with creosote. Most of the so called "inferior" woods are well adapted to the treatment, and this is espeically true of cottonwood, aspen, willow, sycamore, low-grade pines, and some of the gums. When properly treated, these woods outlast untreated cedar and oak, which are becoming too scarce and too much in demand for other uses to allow of their meeting the demand for posts, etc. Impregnation with creosote has been greatly cheapened by the introduction of the "open tank." A tank with a bottom 12 square feet in area will suffice for treating forty or fifty 6-in. posts a day, or double this number when two runs per day can be made. Properly treated, it should give service for at least twenty years. Experiments of the United States Forest Service show that with preservative treatment the durability of lodgepole pine in Idaho is increased sixteen years. Through preservative treatment other woods are fitted to take the place of cedar, of which the supply is rapidly becoming exhausted.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Suggested Improvements for the Steady Rest—A Chuck for Finished Work

The line cuts show a steady rest for the lathe which I would suggest in place of the form now generally used, which has a number of weak features which I have endeavored to eliminate.

The weakest feature of the present form is the hinged joint at the back. I have substituted for this the joint shown in Figs. 1, 2 and 3. The pin should be a loose fit in the cover lugs, and the bolt offset, so that it will clamp on the face *F E*, where *F E* is not cut away to allow for swinging up. The faces *F E* should be finished.

The next weak point is the design of the jaws. They very seldom fit in the slides and are clamped by a solitary cap screw which permits them to rock, and also makes it necessary to have a long slot in the jaws. In this case I have put in a solid jaw, held by the gib *G* clamping it between the two tapered faces *H* and *I*, as shown in Fig. 4, and having the nut at the back of the rest.

I have put in collar bolts in place of the more usual set screws for adjusting the jaws, for I think they are stronger and they do not project so far out. The center of the rest should be bored in line with the lathe centers to assist in setting the work parallel, in order that straight holes can be bored without loss of time by trying each cut.

It will be observed that there are no projections on the front of this rest, the jaws being right at the outside; usually the cap screw on the front lower jaw is in the way when using parting or threading tools on work which is near the full size of the opening in the rest. Every nut and screw on this rest would use the same wrench in place of the four wrenches commonly required.

It might be a good plan to dovetail separate faces on the jaws so that the babbitt or fiber faces could be put in when used on finished work. This rest would be more expensive than the one ordinarily used, but a machine costing what a lathe does could easily stand another $5 or $10.

The fact that the steady rest is the same today as it was 40 years ago would seem to indicate that it has received no attention, and I submit this design merely to call attention to it. Figs. 5 to 7 represent a chuck for finished material and which consists of but two parts: the body *A* of cast iron, bored and threaded to fit the lathe spindle, and the bolt *B* with its nut which does the holding.

The original of this chuck takes a 1-inch bar and the bolt is made ¾-inch with a ⅝-inch nut; the bolt hole is drilled ½ inch off center so that one-half of the bolt is bored away when the center hole is finished. The smaller sizes are held by bushes which fit the chuck.

Ottawa, Ont. JOHN STEVENSON.

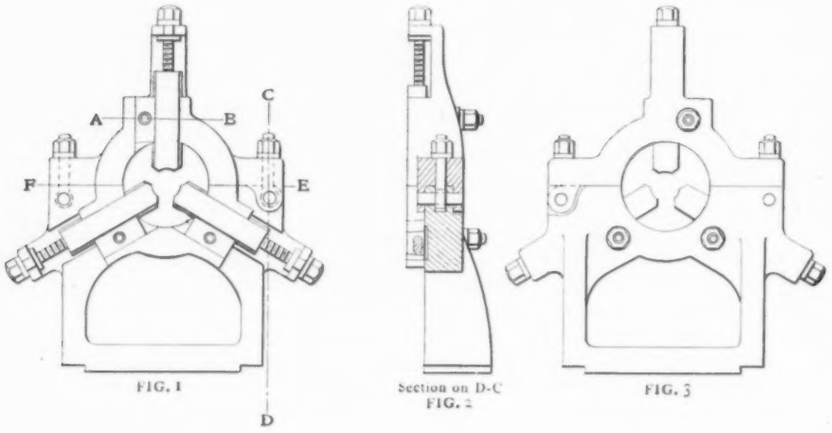
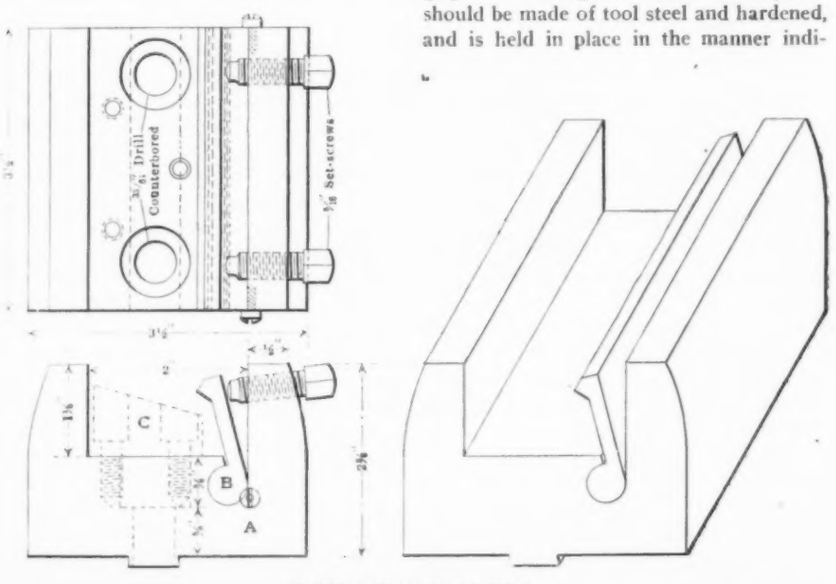


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

A STEADY REST AND A CHUCK

A Handy Milling Fixture

A milling fixture that is of universal range, within its class, is shown herewith. Referring to the sketch, *A* is the body or box, made of machine steel, with a tongue to fit the slot in the platen of the machine on which it is to be used. *B* is the grip for holding the work securely; it should be made of tool steel and hardened, and is held in place in the manner indi-



HANDY MILLING FIXTURE

cated. No dimensions for *B* are given, as they may be varied to suit, although the approximate proportions, as shown, will be found serviceable.

A work pad *C* is shown by dotted lines in the front view, it being held in position by three ¼-inch fillister-head machine screws, not shown in sketch. By making pads to fit work of different outlines the fixture will be suitable for a large range of work, and as the pads may be made in strips, cut to proper lengths, drilled and the top outline machined as wanted, they can be made at a small cost. An isometric perspective view of the box and grip is also shown, giving a clear idea of the general proportions of the fixture.

Boston, Mass. J. E. MAY.

A Jig for Testing and Setting Automobile Cams

Having recently to make various types of cam shafts, chiefly cut from the solid, it was found necessary to test the accuracy of these shafts after they had been milled, also to test the templets from which formers had to be made for the cam-cutting machine. As no motors were to hand in which to try the cam shafts in their proper places, by means of the marked off flywheel, it was necessary to make a jig. The various flywheel settings were then obtained and all was plain sailing.

A base *A* was made with a T-slot running from end to end. On this a pair of forged angle pieces *S S'*, ¾x2x7 inches high, were tongued to slide in the T-slot, and drilled for centers 6 inches in hight. On the end *S'* is an adjustable clamp *G* provided with a thumb screw *W*. The other piece *S* is provided with a screw center and a clip for holding a pointer *P* to an index plate *X*.

The piece *B* is made to represent a tappet and valve stem as found on a motor, being adjustable for different sizes of cams. The clearance between the tappet and valve is regulated by the nurled nut *N*. This whole piece is made to slide freely the length of the jig, and can be clamped in any place by the nut provided.

The index plate *X* is a piece of sheet steel 3/32 inch thick and 11½ inches in diameter, with a 1-inch hole in the center. In marking out this plate it must be remembered that the cam shaft goes half the speed of the flywheel, so that the piston travels the complete cycle on the one plate. It is only necessary to mark out one set of operations having divided the plate into four equal parts to represent the four cylinders firing at right angles to each other. In the example taken the order of firing is 1, 4, 2, 3, the tapered end of the shaft representing No. 1 cylinder.

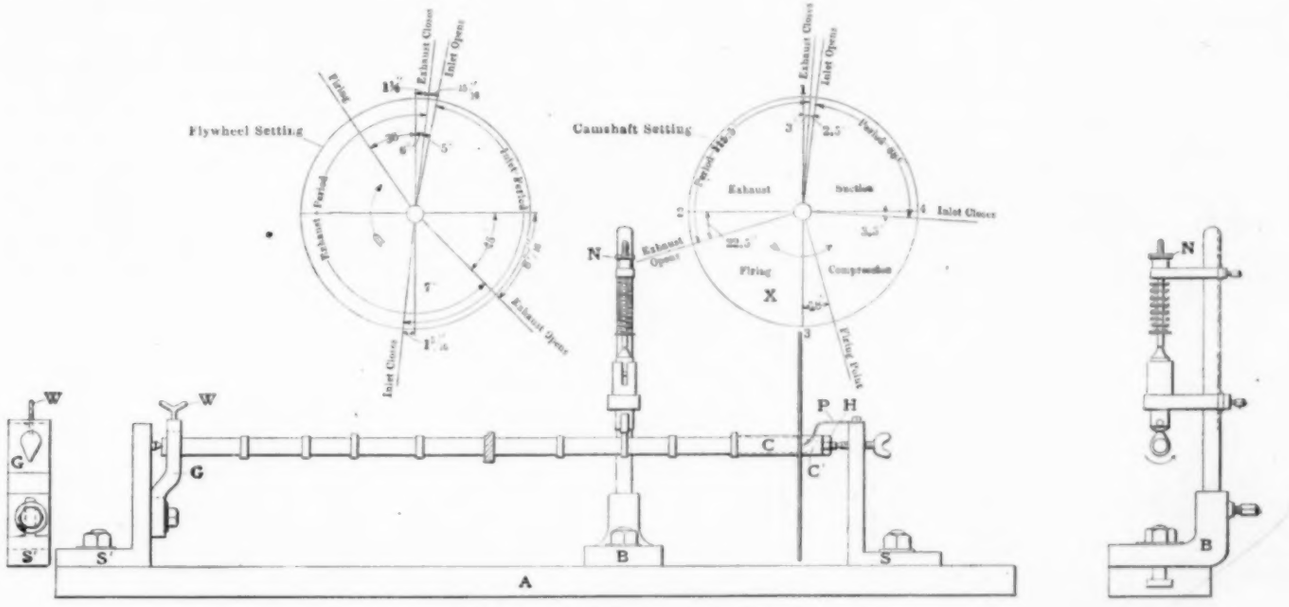
To use this jig place the index plate *X* on the threaded end of the shaft between the two collars *C C'* and secure it with nut *H*. Mount the shaft in the centers and adjust the clamp *G* up to the under side of the shaft, then slide the tappet piece *B* over the first cam, i.e., No. 1 cylinder exhaust, set it to the correct clearance, which on most engines is 0.015 inch, then turn the shaft in the direction indicated by the arrow until the cam just starts to lift the valve; here clamp the shaft by means of the thumb screw *W*, then by loosening the nut *H* the index plate is turned around until the pointer *P* is on "exhaust opens," here clamp the plate by means of the nut *H*, loosen the thumb screw *W*, turn the shaft around until the tappet just leaves the valve stem, the pointer *P* should then be on "exhaust closes." By moving *B* along until it comes over the next cam (No. 1 cylinder inlet) we can try this cam in the same way.

For the next pair of cams we bring our plate around until *P* indicates No. 1 cylinder. Here the shaft is clamped at *W* and the plate loosened and moved around until No. 4 comes under *P*, loosen the clamp nut *W*, then No. 2 cylinder cams are ready to be tried. After this move to No. 2, then to No. 3 on the plate, following out the same order of operations after trying each pair of cams. By having a sharp pointer, and being careful to see that it comes dead to the lines, great accuracy can be obtained.

This jig has been found extremely useful for setting cams on shafts where the cams are not solid with the shaft. Each index plate can be marked on both sides for different types of engine. When not in use an extra pair of centers can always be made use of, and, with the clamping device these have been found very useful for marking out jobs held on a mandrel where the weight is out of center.

D. CHESTERFIELD.

Birmingham, England.



A JIG FOR SETTING AUTOMOBILE CAMS

A "Sand Stick" for Section Lining

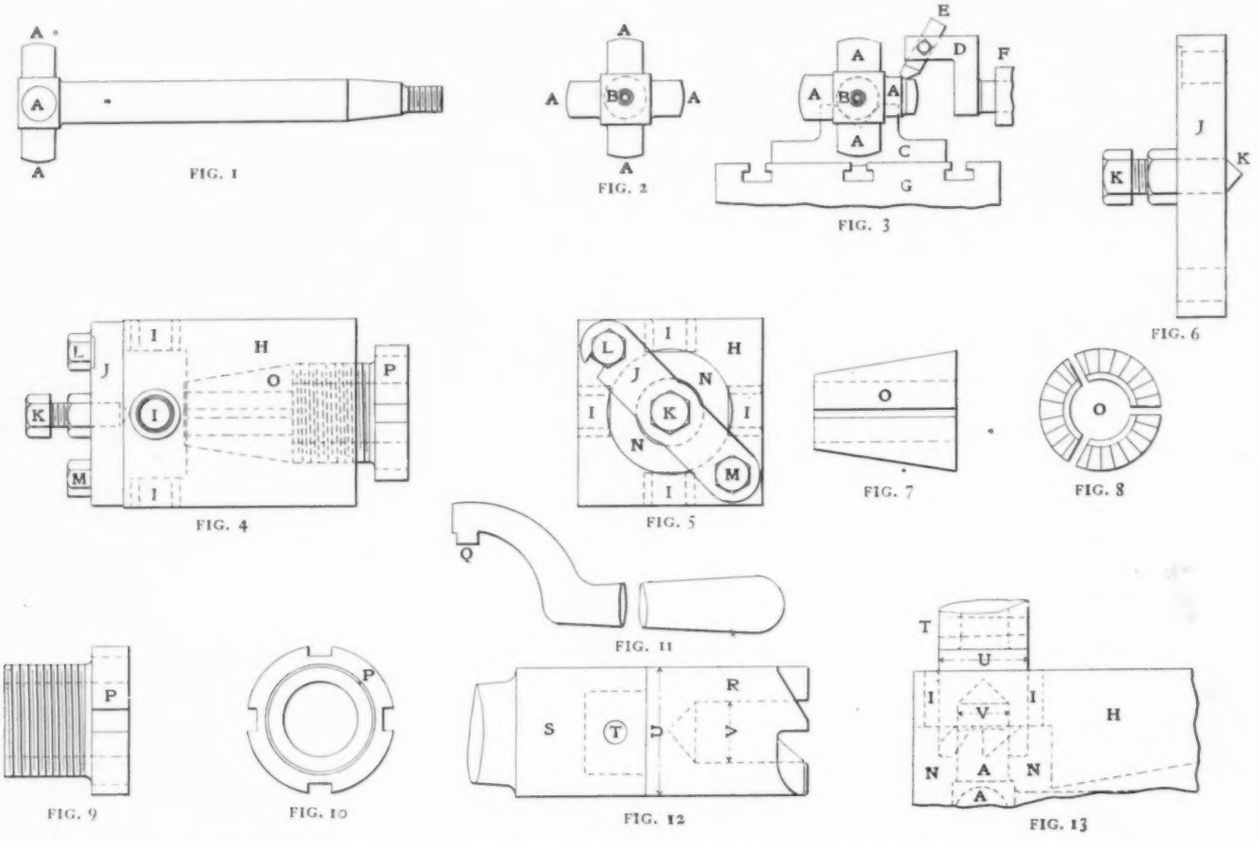
Every draftsman should be provided with a "sand stick," a piece of hardwood about 12x1½x5/16 inches, having a strip of fine sandpaper glued to the under side. This is used to slide the triangle on when drawing parallel lines and is much more satisfactory than sliding on another triangle.

S. PIPER.

Machining the Star End for the Differential Bevels on the Line Axle of a 20-Horse-power Automobile

Fig. 1 shows the elevation, and Fig. 2 the end view of a live axle for a 20-horse-power automobile. This is made from a good grade of case-hardened steel, and machined all over. The forging is first turned on the shank, and threaded at the outer end, and also turned over the top of the star end, and faced at the end. This operation presents no difficulties and is a typical engine-lathe job. When we came to turn up the four short arms *A* at the end, which are 1 inch in diameter, and must be spaced accurately, we found they took quite 8 hours each on a plain milling machine, our method being that shown in Fig. 3. *B* is a center hole left in the end; *C* is one of two V-blocks to support the shaft and clamp it down into; *D* is a turret-lathe tool holder and *E* the cutting tool; *F* is the milling-machine spindle end, and *G* the table. We turned the four arms up, as shown, having to take several cuts on each, as the forgings are very rough. The dividing had to be done by slackening the cramping bolts and using a surface gage, thus requiring a high degree of skill. After completing about half a dozen by this method we started to design a rig for turning these shafts out much quicker than hitherto. This is shown in elevation at Fig. 4, Fig. 5 showing the end view, and Figs. 6 to 12 show the principal details. This fixture we use on a Bickford radial drill press, and can turn the shafts out at the rate of 2 hours each now, making a first-class accurate job. *H* is a gray-iron square block, planed up accurately all over, and recessed out at the end large enough for the star to go just inside, as shown at *N*, in Fig. 5, also in Fig. 13, which shows the cutter in operation. *I* are the four hard-steel bushes driven in *H* for guiding the hollow mill when operating on the star ends. *J* is a swinging end clamp, which carries a pointed set screw *K* and lock nut. *L* is the locking screw, and *M* the pivot on which *J* swings. *O* is a split collet, as shown in Figs. 7 and 8. *P* is the security nut, shown in Figs. 9 and 10. Fig. 11 shows the spanner for operating it, the projection *Q* engaging in the four notches cut in the periphery, as shown. Fig. 12 shows the type of hollow mill *R* used, and *S* the coupling socket. *T* is the driving peg. The outside diameter of the mill *U* is ground up after hardening to be a nice working fit in the bushes *I*, and the inside is bored out the same diameter as the finished size of *A*, for the finishing cutter, the rougher being 1/16 inch larger, two cuts being necessary to produce good work.

To set the work in position we swing the clamp *J* around, by slackening the nut *L*, and the center *K*. We then slacken the collet nut *P* and insert the shaft, bring *J* into position and secure *L*, which locates the center *K* accurately with the center of the shaft. *K* is adjusted and the shaft pushed up to it, then *P* is tightened, which forces the collet *O* down the taper, and secures the shaft firmly and wedges the end onto the hard-steel center. The fixture is clamped onto the drill-press table by a single bolt and ordinary plate clamp on top, and after the operator has looked to see that the star ends are set approximately central with the bushes *I*, he brings his roughing mill down and removes the stock down to a mark made on the end with a diamond-pointed turning tool when facing up, extreme accuracy being obtained by the aid of a surface gage; after the first arm is completed, a steel bush is slipped on it, which just fits inside the bushes *I*. This effectually prevents the work from moving under any conditions when operating on subsequent arms. The clamp bolt is then slackened and the fixture turned a quarter turn and clamped down again, and the next arm completed and the remaining two in exactly the same way. Not only do we turn out work in less than one-quarter the time it formerly took without the fixture, but we get a much better job, and far more accurate, as there cannot be any pos-



MACHINING THE STAR FOR THE DIFFERENTIAL GEAR OF AN AUTOMOBILE TRANSMISSION GEAR

sibility of the four arms being out of square with one another. This is a very important factor, as when they are not square the differential bevels do not each take their proper driving strain, due to their teeth not engaging properly with the large bevel.

With the fixture we can also utilize very much cheaper labor, as the risk of scrapping the work is reduced almost to vanishing point, as when the first shaft is accurately completed, the automatic spindle trip can be set, which prevents the operator from going too deep on future shafts. The risk of scrapping work on the milling machine was very great.

B. F. REGINALD.

Coventry, England.

Making and Using a Master Plate

The sketch Fig. 1 shows a casting in which three holes are to be located. The method employed to do this makes it necessary to find the length of the line X.

Knowing that the sum of the divisions of the base $(B + D)$ is to the sum of the other two sides $(A + C)$, as the difference of these two sides is to the difference of the divisions of the base, we can readily find the length of the line X. The sum of the divisions of the base $= 3$ inches. The sum of the other two sides is 4.2416 inches, and the difference of these two sides is 1.4132 inches. Therefore, we have three terms of a proportion

$$3 : 4.2416 :: 1.4132 : 1.9980.$$

The last term gives the difference of the divisions of the base $(D - B)$. Introducing a little algebra we have:

$$\begin{aligned} D + B &= 3 \\ D - B &= 1.9980 \\ \hline 2D &= 4.9980 \\ D &= \frac{4.9980}{2} = 2.4990 \\ B &= 3 - 2.4990 = 0.5009. \end{aligned}$$

The line X divides the triangle into two right triangles, therefore,

$$1.4142^2 - 0.5009^2 = 1.7490,$$

and

$$\sqrt{1.7490} = 1.3225 = X.$$

We have now obtained our figures and are ready to apply them to the work. First have a cast-iron plate about ¾ inch thick and somewhat larger than the casting planed up all over and squared. Lay out the holes roughly with the dividers and drill a little smaller than finished size. The plate may now be scraped, when we are ready to bore the holes. Swinging the plate upon a true face plate, we bore hole No. 1, leaving about 0.0006 inch to lap. We now clamp a parallel, as in Fig. 2, under the plate and in contact with it to enable us to slide the plate along just 3 inches. To accomplish this we turn up a disk, or secure a gage which measures 3 inches and insert it between the end of the plate and a stop, being careful to clamp the stop just 3 inches from the edge. Having secured the stop we loosen the plate and carefully slide it along on the parallel until in contact with the stop. Clamp the plate and bore hole No. 2, as in Fig. 3. To locate hole No. 3 we loosen the plate and move it away from the stop 0.5009 inch (for distance B), as in Fig. 4, measuring this off in the same manner as before. Clamp the plate and also a parallel in contact with the opposite edge, as shown in Fig. 5. Now remove the parallel from the lower edge, as shown in Fig. 5, and clamp a stop 1.3225 inches from the edge for distance X. Loosen the plate and carefully keeping its edge in contact with the parallel let it slide until in contact with the stop, as in Fig. 6. Clamp the plate and bore hole No. 3. If these operations are carefully performed the holes can be located accurately to 0.0005 inch.

Any one hole in all of the castings, Fig. 1, may now be bored and lapped independently of the master plate; then we are ready to locate the other two with it. A stud with a shoulder is driven into the hole of the master plate corresponding to the finished hole in the castings. A casting is then mounted on it and the hubs of the other two holes are located central with the holes in the plate and clamped there. A lathe-center blank is next driven

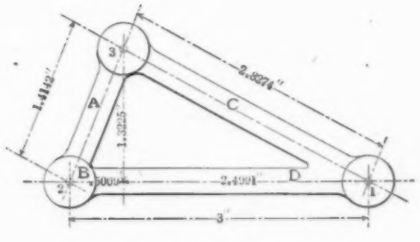


FIG. 1 The Work

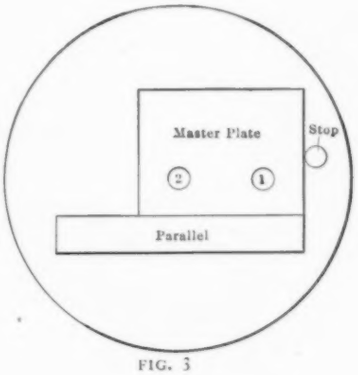


FIG. 3

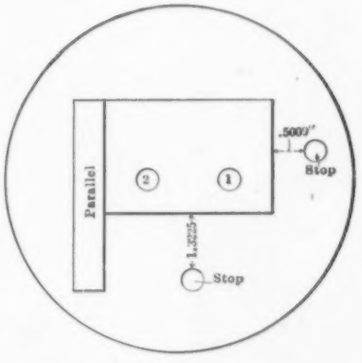


FIG. 5

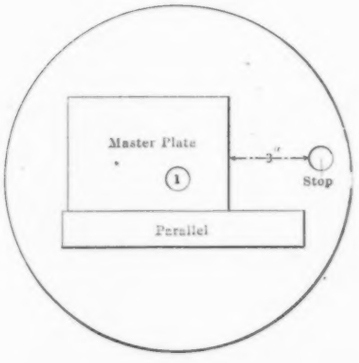


FIG. 2

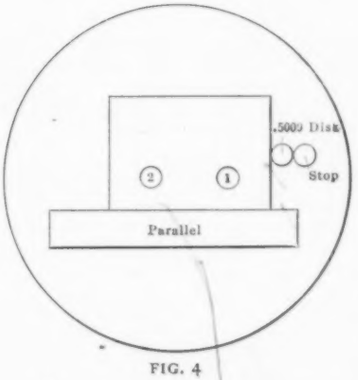


FIG. 4

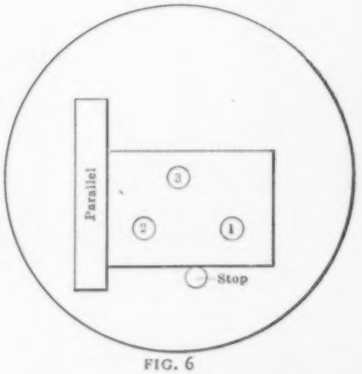


FIG. 6

MAKING AND USING A MASTER PLATE

into the lathe spindle and turned down (leaving a little to polish or lap) to the same size as the holes in the master plate. The master plate is now slipped on the stud and against the face plate and clamped. All of the holes No. 2 or No. 3 can now be bored, after which we remove the master plate and drive another stud into it to correspond with the hole bored. The castings are then mounted on these two studs and the last hole bored as before.

Elgin, Ill. GUS HAESSLER.

A Drill Attachment for Drilling Taper Holes Large at the Bottom

With the advent of the steam turbine many new problems have arisen, and among them the drilling of conical holes with the small diameter on the outside and the larger one on the inside. Fig. 1 shows a Parsons steam-turbine spindle consisting of several parts. The taper pin *C* must be inserted from the inside in order to overcome the centrifugal effect of the high speed. When fitted from the inside the pin will also be tightened by expansion, owing to the increased temperature caused by the superheated steam used in the turbine. It is impossible to drill the hole from the inside because there is not room enough.

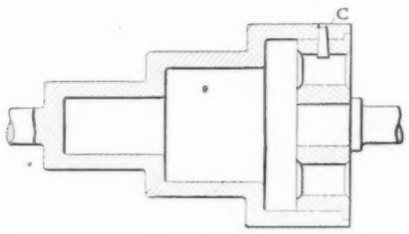


FIG. 1. THE WORK ON WHICH THE DRILL IS USED

With the tool herein described it is possible to drill a taper hole from the narrow end. The tool consists of a drill shaft *B* in Fig. 2 with a cutter on the end. This drill shaft is held by a cast-iron bushing *A* in which runs a second bushing of steel *C* The hole in the second steel bushing *C* is neither parallel nor concentric with the center axis of the bush, but is inclined to an angle corresponding with the angle of the taper to be drilled.

The drill shaft has a key and the steel bushing a keyway so that the shaft is prevented from turning in the bushing *C*, and can move only in the direction of the axis. The drill shaft runs on its lower end in a spherical bearing *E* which is movable in all directions. The upper end of the drill shaft is connected with a spindle of a drilling machine by means of two universal joints and a taper fit in the drilling spindle.

After having drilled the cylindrical hole and recess for the conical center projection *J* on the cover of the ball bearing, which serves to properly locate the tool in the correct position, it must be clamped with a ring *Q* on the steam-turbine spindle, as is shown in Fig. 3. The drill work itself is very simple. After having adjusted the cutter by the screw *I* it can be done with a single chip from the narrow end to the wide one using the feed of the drilling machine. This new tool is very economical and can be used for various purposes.

F. N. PITTSBURG.

Frankfort, Germany.

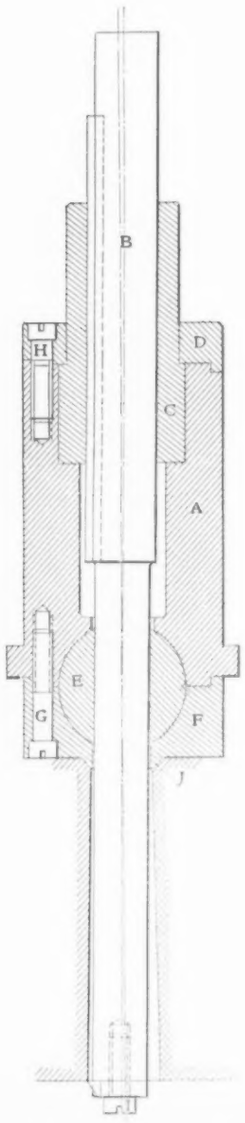


FIG. 2. THE TAPER DRILL

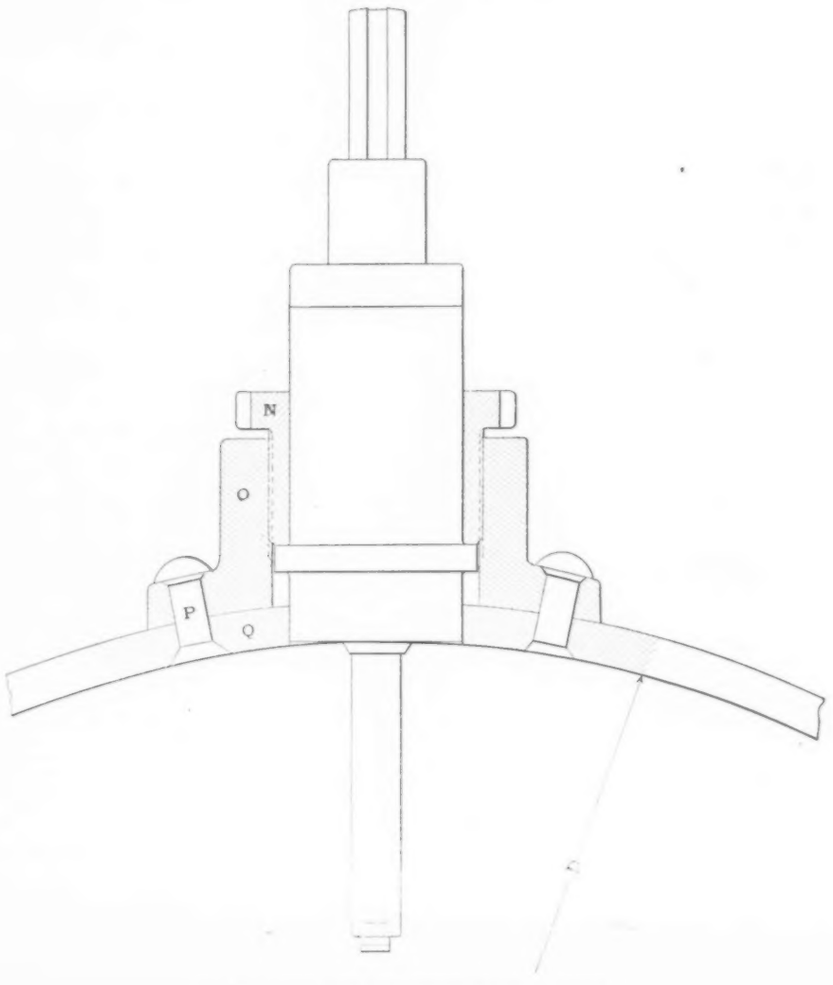


FIG. 3. THE DRILL SECURED TO THE WORK

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

An Anti-chattering Device

A description of an anti-chattering device by William B. Hillard on page 968, Vol. 31, Part 2, brings to mind a method of preventing chattering which I have seen used to good advantage in turning large flywheels. A block of wood which was operated and adjusted by a screw was rigged up on the tool carriage in such a manner that it served as a brake on the flywheel which was being turned. After the cut was started the screw was tightened and the brake applied to the wheel until the chattering entirely disappeared. The tool was ground with very little clearance and the cutting edge was on an angle to prevent the tool from gouging. Of course, by applying a brake to the wheel more power was required to run the machine, but the reduction in time more than offset this. This device proved especially valuable in taking a finishing cut, as the following incident will show. The night man on the job had worked for nearly half the night trying to get a smooth finishing cut on a 24-foot flywheel and when the day man came to work was not much further along than when he had first started. The day man, who was the originator in that shop of the brake method, took hold of the job and in less than an hour had run a finishing cut over the wheel as smooth as any man would care to look at.

Dunmore, Penn. T. W. HOLLOWAY.

Steady Pins in Engine Cylinder Feet

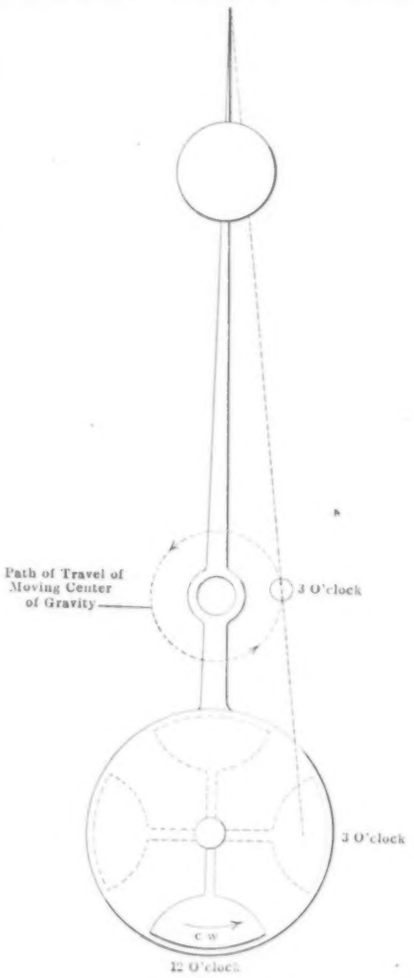
I was interested in the account given by *Engineer* on page 70 of the change made in the method of steadying engine cylinders, but, while appreciating the fact that the shearing area of the keys was substantially increased, I would like to know what provision, if any, was made for steadying the cylinders in a direction at right angles to this. According to the sketch shown, this would seem to have been overlooked, but my experience in such matters is that steadiness is required both ways. Possibly the base was tongued and fitted into a corresponding groove in the engine base, and this would meet the case satisfactorily.

The increased cost in fitting such keys is necessarily much greater than in the case of round ones, and I, for one, would hate to have the job. I am inclined to think in this case, as in others which have come to my notice, that the inspector felt bound to criticize some point of construction, and chose this in default of a better one. I would like to have some other readers' opinion on this point of round keys versus square or rectangular ones.

Detroit, Mich. STANLEY W. MILLS.

A Possible Solution of Osborne's Peculiar Clock

Having seen nothing like the clock problem which Mr. Osborne has put up for solution, I submit the line cut and explanation of how it may be done. I think what appears to be a counterweight is, in fact, a light case containing a clock movement and movable weight.



OSBORNE'S PECULIAR CLOCK

The clock movement is probably arranged to rotate the weight in a counter clock-wise direction, and thus cause the center of gravity of the system to travel around the point of suspension of the hand.

Of course, the hour-hand's movement should rotate its moving weight one revolution about the weight's axis once in 12 hours, while the minute-hand's movement should perform a like rotation each hour.

Washington, D. C. D. A. MANSON.

A Draftsman's Precision Needle Point

On page 24 E. S. McAll shows the way he uses common sewing needles instead of the usual points, in his drafting instruments; I believe the scheme used by a number of draftsmen up this way beats his.

They had a manufacturing jeweler make a lot of bushings for them. These bushings were of a composition metal and turned up the size of the ordinary steel point. A hole the size of a small sewing needle was then drilled through the center and a slit cut lengthwise of the piece, making a miniature split bushing of the ordinary form. The edges of the bushing and the ends of the slot were carefully rounded to avoid any possible cutting of the drawing paper. Some of these bushings have been in use two years, and the draftsmen who have them would not use the regular points under any consideration.

Probably the idea Mr. McAll had in supporting the point of his needle as he did, was to avoid the tendency to spring, but a test of a number of needles inclosed in the split bushings just described show that if force enough to spring the point is used the paper will tear. This was true of both the large and the small instruments; the bushings and needles used were in proportion to the size of the instrument, of course.

Decatur, Ill. ETHAN VIALL.

How Can Air Hardening Steel be Annealed for Making Drawing Dies?

On page 101, your correspondent, who signs himself, H. H. Steel, gives the readers his experience with drawing dies made of air-hardening steel for redrawing steel ferrules or shells. May I ask Mr. Steel if he will give us, through the AMERICAN MACHINIST, his method of annealing air-hardening steel so that it can be successfully worked up into drawing

dies at a minimum cost; also what the lubricant is composed of that he uses when redrawing steel shells?

Bridgeport, Conn. R. EADER.

Chalking Tracing Cloth

The two methods mentioned on page 863, Vol. 31, Part 2, for removing the grease from surface of tracing cloth are all right, but why use chalk or powder at all?

Some years ago I read a little item in the AMERICAN MACHINIST, which recommended using common blotting paper in place of chalk, and since then I have never returned to the old-time idea of chalk with its dirt and general mussy effect. The vital points are a good blotter and plenty of elbow grease.

Once over the cloth leaves the surface clean and free from grease, dust or dirt and it does not matter which side of the cloth you use. This does not seem to be commonly known to draftsmen, as I have never met anyone who was using it in the five drafting departments where I have been employed, but after a demonstration they gladly abandon the chalk box.

Rochester, N. Y. RALPH W. DAVIS.

Construction of Graphical Charts

Prof. Guido H. Marx's article on "Isometric Plotting of Graphical Charts," on page 701, Vol. 31, Part 2, has interested me. This interest leads me to describe and illustrate a method employed by myself for a similar purpose. It differs from the isometric method in that it uses the ordinary rectangular coördinate paper with the addition of lines inclined at an angle of 45 degrees to the axis. The divisions on two of the axes are alike while those of the third are greater in length.

The method of plotting is similar to the isometric, and is shown in Fig. 1. Here, the planes xy, yz and zx are shown in exactly the same relation that they are represented in Figs. 2, 3, 4 and 5. As will be seen, the y-axis makes an angle of 45 degrees with the x-axis, while the z-axis is at 90 degrees to the x-axis. Suppose a point a, whose coördinates are x, y and z, is to be plotted; lay off $x\,y$ in the xy-plane, and at their intersection erect z; a is located.

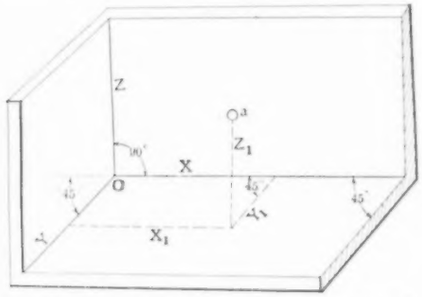


FIG. 1. DIAGRAM ILLUSTRATING METHOD OF PLOTTING GRAPHICAL CHARTS

As I said before, the general method of handling the charts is the same as the isometric, therefore I will not go into details but will show some examples.

Fig. 2 was plotted to show the variation in the shrinkage of cast iron, when the percentage of silicon and the sectional area of the casting varied. The x-axis is used for the per cent. of silicon; the y-axis for the sectional area of the casting; the z-axis gives the shrinkage per foot of length. A glance at this chart gives to the mind a graphical representation of the three variables and their relation to each other.

Fig. 3 is a friction chart for a 6-inch wrought-iron pipe. The general equation for the friction head in pipes is:

$$h = f\,\frac{l}{d}\,\frac{v^2}{2g};$$

where,

h = Friction head,

f = An abstract number, or friction factor which depends upon the degree of roughness of the surface,

l = Length of pipe,

d = Diameter of pipe, and

$\frac{v^2}{2g}$ = Velocity head due to the mean velocity of flow.

By making d a constant, we have the case of three variables that Fig. 3 repre-

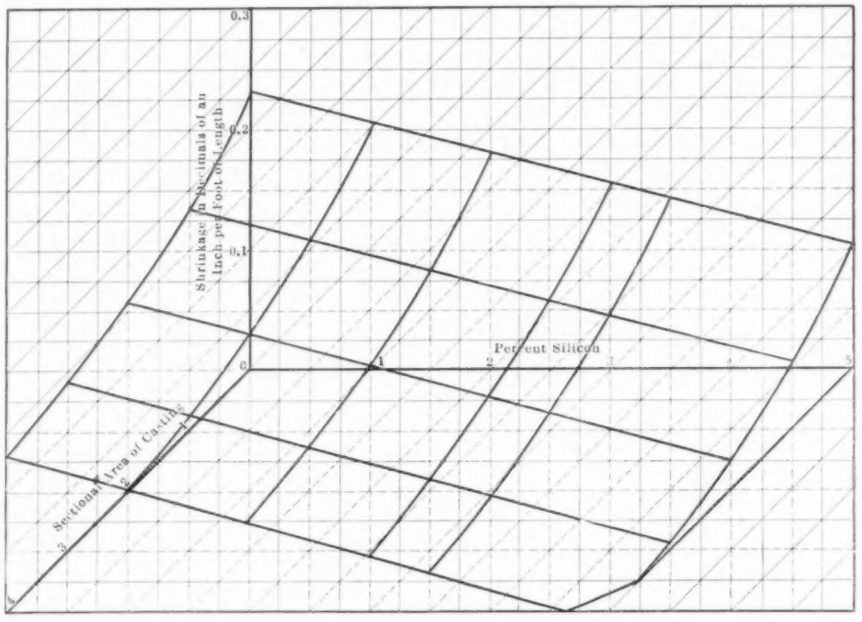


FIG. 2. CHART OF THREE VARIABLES SHOWING SHRINKAGE OF CAST IRON

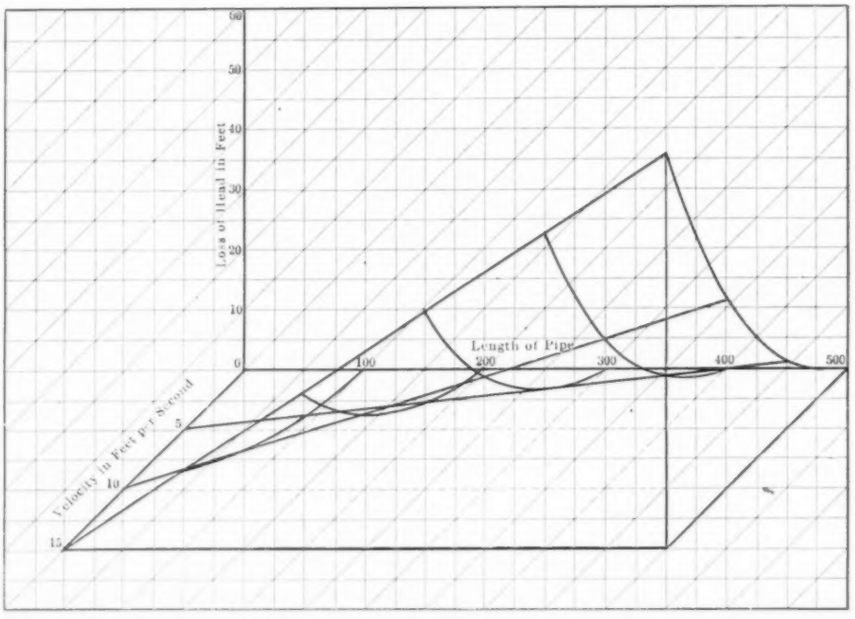


FIG. 3. CHART OF THREE VARIABLES SHOWING FRICTION LOSS IN A 6-INCH PIPE

sents. If we make l a constant the equation takes the graphical form shown in Fig. 4. These two figures, Figs. 3 and 4, illustrate very well the following laws of water friction in pipes:

I. The loss of head in friction is proportional to the length of the pipe.

II. It decreases as the diameter of the pipe increases, and as will be seen varies most rapidly for small pipes and low velocities.

III. It increases nearly as the square of the velocity.

In Fig. 5 we have a graphical representation of the discharge of water from different-sized nozzles under pressures varying from 0 to 300 feet. It shows the general rate of increase in the discharge, when the size of nozzle and the head are increased, and makes a clearer impression on the mind than any table or chart of two variables could do.

This method of plotting equations of three variables has at least two advantages over the isometric method: First, it does not require a special kind of paper but uses the ordinary coördinate paper; second, only two planes are distorted, while in isometric plotting all three planes are distorted.

Aurora, Ill. JOHN B. SPERRY.

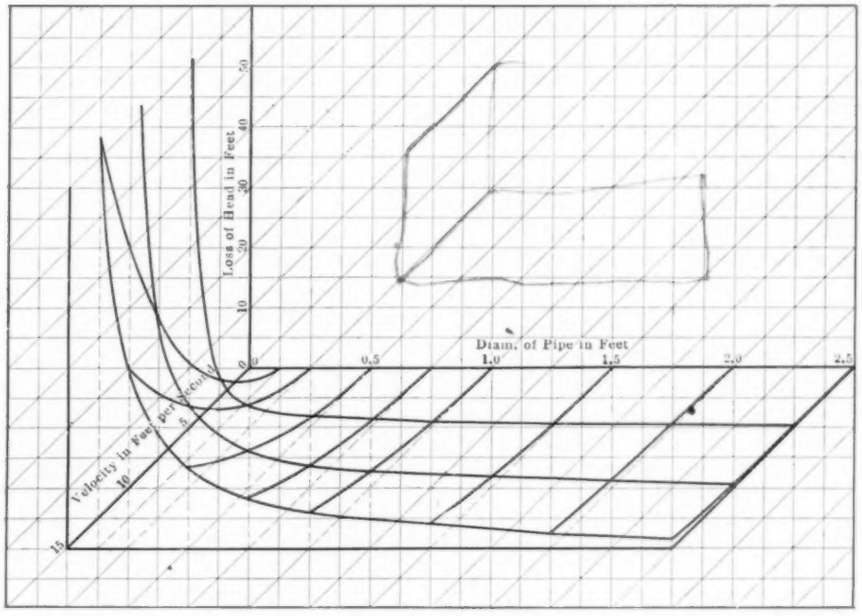


FIG. 4. CHART OF THREE VARIABLES SHOWI NG FRICTION LOSS IN PIPES OF DIFFERENT DIAMETERS PER 100 FEET OF LENGTH

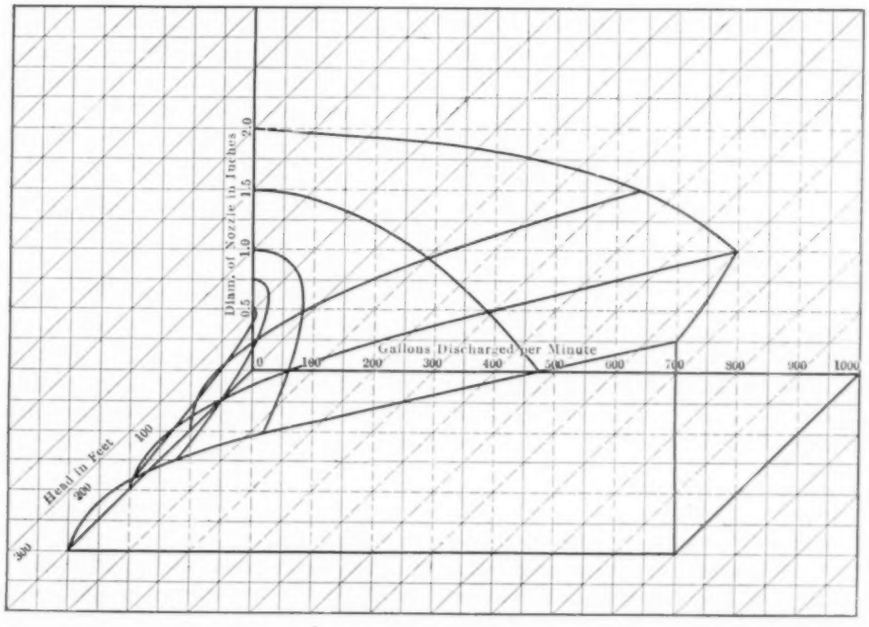


FIG. 5. CHART OF THREE VARIABLES SHOWING DISCHARGE FROM NOZZLES UNDER DIFFERENT CONDITIONS

Smallest Screw Machine

Referring to a note in a recent issue concerning the smallest screw machine made, we are informed by B. C. Ames, of the B. C. Ames Company, Waltham, Mass., that he is now building a machine for screws even smaller than this. Their diameter is only 0.018 inch and there are 240 threads to the inch. The machine is entirely automatic and the production is the same as the one mentioned, 600 complete screws per hour including the slotting of the head.

Casting Packing Rings

According to page 954, Volume 31 of the AMERICAN MACHINIST, in the article, "Some Railroad Tools," by Ethan Viall, I see that Mr. Crownover is casting packing rings to size and shape wanted, and simply reaming the hole for the rod.

I have been going him one better by casting the rings right to size all over *and cut ready to use* by simply cutting off gate. I do this by blocking my molds opposite the pouring gate. I find these rings give very good service. I have had two sets in use for the past five years on a pair of De La Vergne ice-machine engines going 24 hours per day, 9 months each year.

Poplar Bluff, Mo. T. G. VAN SANT.

Method of Making Armature and Stator Core Segments

I have read with much interest the letter signed by F. M. Pittsburg, Frankfurt, Germany, on page 785, Vol. 31, Part 2, concerning his method of making armature and stator core segments. I would like to have Mr. Pittsburg explain how he means to present the sheet prepared by his first operation in the shearing and punching die, to the notching press. I suppose that the first operation die acts upon a strip of sheet steel cut the full length of the sheet, say 8 to 10 feet. How can such a sheet be presented to the notching press and what style of notching press can he use in order to obtain the proper feed at the diameter which corresponds to his cutter D shown in Figs. 6 and 7? How is such a sheet held in his notching press? Moreover, it appears to me that the shearing cuts 4 and 5 will leave the first two radial sides bent down (as the scrap still remains attached to the sheet) in such a way that it will interfere with the feeding over the notching die.

As this is a subject of considerable interest to many of your readers, I hope that Mr. Pittsburg will explain through your columns more clearly, just how this is to be done.

Paris, France. G. MASSIE.

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February 11	19,250
February 18	19,250

This paper reaches 33,250 *separate readers each month and* 19,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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German Industrial Schools

The impression has been growing upon us for some time that there is a large misapprehension in the public mind regarding German trade schools. What everyone has in mind when discussing this subject with relation to the needs of this country, is a system of schools which shall teach, primarily, trades, that is, manual skill, and it seems to have been assumed, because Germany has a well developed system of industrial schools, that these schools are of this type. There is, however, very little evidence to support this assumption and some reasons for believing it unfounded.

Any fully developed system of industrial schools must include, first, a system of trade schools as defined above and, alongside, or part of it, a system of schools giving academic instruction in subjects related to the trades taught, and the indications seem to be that whereas Germany has developed the second class of school to large proportions she has not developed the first to any considerable extent. Meanwhile, because the German schools which have been developed come under the broad classification of industrial schools, it has been assumed that they include and, indeed, consist chiefly of trade schools properly so called—an assumption which, according to the best information that we can gather, is an error.

We first made reference to this subject in an editorial, "A Sample Report on German Industrial Schools," published on page 664 of Volume 31, Part I. In this report we referred at length to a report on the industrial improvement schools of Wurtemberg, by Alfred A. Snowden, and pointed out that it related almost exclusively to schools of the second class, those of the first receiving bare mention only. Thus, referring to the schools described in the report, we said: "Regarding their teaching of the subjects which it is proposed to teach here, or their manner of training pupils for the trades, we find almost nothing, and, indeed, most of what we do find regarding the work done would lead one to believe that their connection with the manufacturing interests of the country is remote and indirect and that comparatively little attempt at the actual teaching of trades is attempted."

Following this quotation we gave samples of the courses of study, which are purely academic, although related to industrial work, and following these courses of study we said: "There is certainly little about any of the courses of study of which details are given to suggest the teaching of trades as that term is used here, although they do, of course, imply the teaching of artistic handicraft."

We now have additional information on this subject in the article, "Trade School Conditions in Europe," by John M. Shrigley, president of the Williamson Free School of Mechanical Trades, published elsewhere in this issue, in which we find the statement, "Even today, however, there are not nearly as many trade schools in the broad sense of the term in Europe as there are generally supposed to be. I mean such schools as give complete apprenticeships in themselves with a proper collateral training."

We are, of course, still very much in the dark regarding the actual extent of trade schools in Germany, although it seems to be clear that the misapprehension to which we have referred is a fact. Mr. Shrigley speaks from personal knowledge and investigation of European schools and he has had the advantage, which few other investigators have had, of possessing the manufacturer's viewpoint, which has made the confusion growing out of the use of the general term, "industrial school," impossible with him.

The situation has its encouraging side. If schools of the type which it now seems reasonably clear comprise the German system are really effective, as we are bound to assume in view of the universal testimony to that effect, then their establishment here is a far less formidable matter than is the establishment of trade schools as we use the term. On the other hand, if trade schools, properly so called, can be established here on a large scale it would appear that, so far as existing conditions in the world are concerned, this country has almost a free field for developing a new type of school of vast usefulness. It has been assumed that we have a long stern chase ahead before we can even catch up with the present German position, and that is true as far as the German type of school is concerned, but as regards trade schools properly so called, the two countries are, apparently, not far from even, and with the public aroused to their necessity here, whereas there is every indication that the German people are rather more than completely satisfied with the type of school they now have. Moreover, instead of following the example of others, we have a vast opportunity to develop a new type of education and to lead the world in doing it.

Walter Morrison Allen

Walter Morrison Allen, works manager of the Warner & Swasey Company, passed away on the morning of February 8, at his home in Cleveland, Ohio, where for several weeks he suffered from a severe illness.

Mr. Allen was born in Bristolville, Ohio, December 14, 1866. His father was engaged in the lumber business in Cleveland, but died when Mr. Allen was only seven years old. Upon his death Mr. Allen's mother, with her three children, returned to her early home in Cherryfield, Me.,

and it was there that his early education was acquired in the local schools.

As a boy he showed great aptitude for things mechanical, but the small shops of this coast town offered little besides a box factory and some boat works, in both of which he demonstrated his skill. When only 16 or 17, he frequently went to the nearest railway station and back, a distance of 30 miles, to study and make drawings of the locomotives that passed that point. At 18, on April 20, 1885, he began work as an apprentice to the machinist's trade in the works of Messrs. Warner & Swasey, and his entire course was marked by his earnestness, ability and integrity. During this period he was given special opportunities in the drafting room and, at the completion of his term, he was still kept in this department where he developed rapidly and of which, in 1891, he was made the head.

During the next two years, the details of the design and construction of the 26-

WALTER MORRISON ALLEN

inch telescope of the naval observatory and the 40-inch of the Yerkes observatory came largely under Mr. Allen's direction.

In 1893 he had charge of the firm's exhibit at the Chicago exposition, and on his return, when scarcely 27 years of age, was made superintendent of their works, a position he held with increasing efficiency during the next six years. In 1904 he was made works manager of the company, the position which he held at the time of his death, and one which involved not only general supervision of the works, but an active part and responsibility in the business management of the company.

Mr. Allen ranked high as a designer of machinery and tools and was gifted with quick perception and good judgment. He was unusually well posted in engineering subjects generally and took an active part in the planning and carrying out the details of construction of the present new shops. He was unassuming and thoughtful, administrative and forceful, and is mourned by a host of warm, personal friends to many of whom his life has been an inspiration and help.

He was a member of the American Society of Mechanical Engineers, the Cleveland Engineering Society, the Cleveland Chamber of Commerce, the Colonial Club, and the Automobile Club of Cleveland.

He had traveled much in the interests of the company, visiting England and the continent in 1897-8 and again in 1900, on which occasion he was accompanied by his wife Minnie May, whom he married in 1888, and who, with two sisters, survives him.

David E. Harding

David E. Harding, treasurer of the S. W. Card Manufacturing Company, Mansfield, Mass., died on February 2, after a brief illness.

Mr. Harding was born in 1826 in the town of West Mansfield, in which place he lived his entire life. After completing a common-school education he entered the steam industry, in which he remained a number of years, becoming a member of the firm of Comey & Rogers, which dissolved in 1872. In 1875 he was elected to the legislature and served with considerable distinction. His next few years were spent in looking after his personal interests, and in 1881 he entered into partnership with S. W. Card, who was a manufacturer of taps and dies. The business flourished under their management and in 1894 it was formed into a stock company. Mr. Harding was elected treasurer, in which position he served until his death.

Mr. Harding possessed a personality that made him a highly respected citizen in Mansfield. He was distinguished as a public-spirited man, and honored as a friend and associate.

A New Engineering Society

A number of Hungarian engineers and architects pursuing their professions in this country have organized the "American Society of Hungarian Engineers and Architects." The society has two objects: First, to bring in closer touch engineers and architects of Hungarian extraction, living in this country, and to give moral support and information to newcomers. Second, to encourage the exchange of engineering, technical and industrial information between the technical men of Hungary and of the United States and to foster technical societies, sciences and industries.

The society will hold monthly meetings for the reading and discussion of papers. The membership consists of mechanical, electrical and civil engineers, chemists, architects and craftsmen. Following are the officers of the new society: President, A. Henry Pikler, Crocker-Wheeler Company, Ampere, N. J.; vice-president, Karoly Z. Horvay, Building Bureau of Board of Education, Brooklyn, N. Y.; secretary, Zoltan de Nemeth, New York Edison Company; treasurer, Sandor Oesterreicher, New York Edison Company; assistant secretary, Ernest L. Mandel, Bureau of Commissioner of Public Works, New York City. The society's business address is Box No. 103, New York City.

Personals*

J. J. Keefe, for a long time connected with the pneumatic tool trade, has recently joined the forces of the Independent Pneumatic Tool Company at the Chicago office.

Claude E. Cox, engineer with the Cleveland Automobile Company, has become associated with the Interstate Automobile Company, Muncie, Ind., as engineer and assistant manager.

L. F. Nielsen, of the Nielsen & Reed Machine Works, which was recently acquired by the Universal Motor Company, Denver, Colo., has become superintendent of works of the latter concern.

J. W. Carrel, formerly special representative of the AMERICAN MACHINIST in Europe, has accepted the position of sales manager of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.

James R. Pearson, chief draftsman and designer of the Warner & Swasey Company, resigned February 1 to become vice-president and superintendent of the Acme Machine Tool Company, of Cincinnati.

Thomas Irving Taylor, manager of the Taylor Machinery Company, Boston, Mass, has just returned from a 10 months' trip around the world, during which he visited a number of the South Sea islands as well as New Zealand and Australia.

R. K. LeBlond, with Mrs. Le Blond, and Philip Fosdick with Mrs. Fosdick and family, sailed in the Grosse Kurfurst February 11, on a cruise through the Mediterranean to Egypt and other eastern countries. They expect to be gone about three months.

Thomas G. Fowler, for the past eight years general foreman of the B. F. Sturtevant Company, has resigned his position to accept the general supervision of the manufacturing department of the American Sub-Target Company, Boston, Mass. Mr. Fowler was held in high esteem by both those above and under him, and on his leaving he was presented with a handsome watch and chain as a token from his associates at the Sturtevant works.

*Items for this column are solicited.

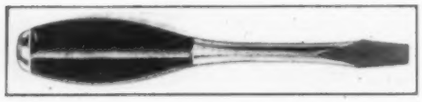
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

An All-Steel Screw Driver

The half-tone shows one of a line of all-steel screwdrivers which has been brought out by the Billings & Spencer Company, Hartford, Conn. The cruci-



AN ALL-STEEL SCREWDRIVER

form handle forged in one piece with the blade insures solidity and a good grip.

A Planer for Locomotive Cylinder Work

The method adopted in the machine to provide strength and rigidity for the planer tools of side heads when used on long overhang work, is novel and shows a careful consideration of the strains involved. The making of vertical ways on the inside of the uprights, gives a good leverage for the supporting bracket and seems to be an entirely new way of handling a difficult proposition. The details are shown in Figs. 1 and 2, while Fig. 3 shows how it appears as a whole.

This is a 72x72x18-foot planer built for machining locomotive cylinders and particularly for cylinders with piston valves.

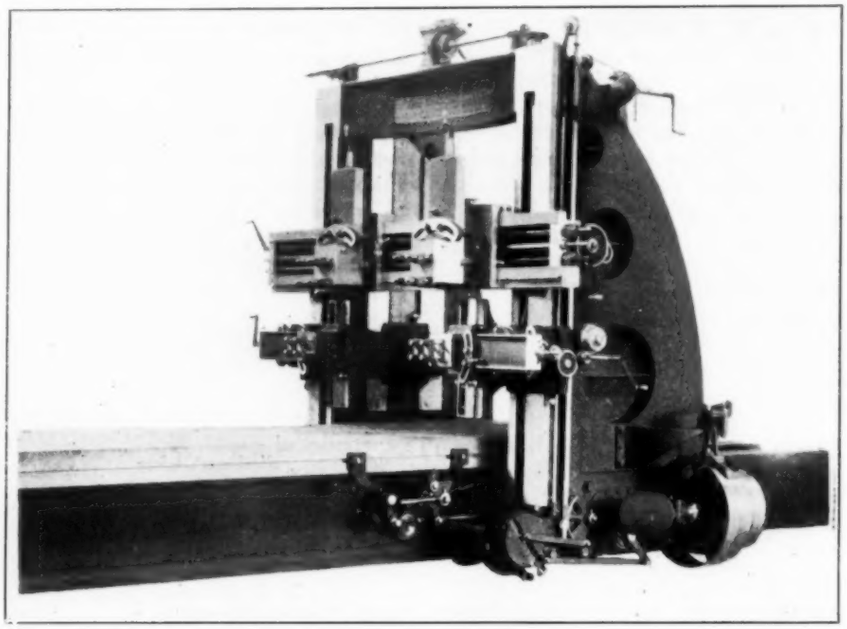
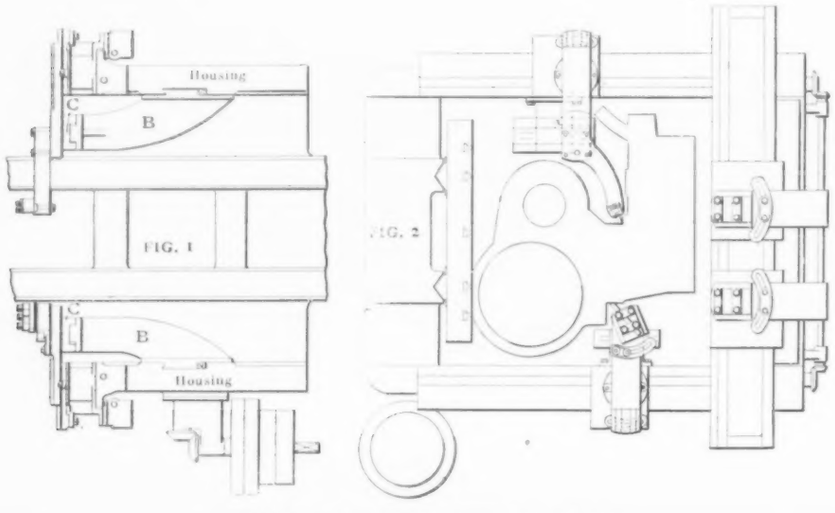


FIG. 3. PLANER WITH SPECIALLY SUPPORTED SIDE-HEADS

The machine itself is a regular planer, excepting the side heads, which are a radical departure from the usual practice. The housings, Fig. 1, are machined on the inside with a dovetail toward the front and square on the opposite, into which fits bracket *B*. This bracket is counterbalanced with chain and weight, which can be seen in Fig. 3, a chain being used in place of a rope, so that a crank could be applied to the sprocket wheel for raising and lowering this bracket to suit the various cylinders.



DETAILS OF THE SPECIAL CYLINDER PLANER

This bracket is secured to the housing by tightening the taper gib on the straight side which forces the bracket against the dovetail and draws it against the bearing. The front end of this bracket *B* is made a rectangular section, which is machined and scraped parallel with the housing. On this is fitted a shoe marked *C*, which has a dovetail on the opposite side that fits the cross-slide of the side head. After the slide is run on this shoe, it is then adjusted on the bracket by the two taper gibs that can be seen in Fig. 3. After this is done the shoe becomes a part of the side head so that when the side head is moved up or down the shoe is carried with it, sliding on the bracket *B*.

When it is necessary to reach out, say, 24 inches from the housing edge, this bracket offers an additional support to the side head greatly diminishing the strain which usually takes place on work of this kind, when the side head is run in to its extreme length. The bracket *B* was made of a length to clear the projections on all sizes and make of cylinders and yet have enough bearing so that the shoe *C* would never extend over the bearing on the bracket.

Whenever the machine is to be used for other purposes than cylinders, the slide can be run back in the usual way on the side head, and the bracket raised up out of the way. Then the machine has the usual full capacity for ordinary planing.

Fig. 2 shows one of the most difficult cylinders to plane, in place on the planer table and illustrates very plainly the advantage of supporting the tool where it is necessary to reach out so far to get at the work. This is one of the latest productions of the Cincinnati Planer Company, Cincinnati, Ohio.

Combination "S" Wrench

This is a double-ended S-wrench, having smooth jaws at one end for bolts and nuts and a serrated jaw at the other end for gripping pipes or other round pieces.

COMBINATION "S" WRENCH

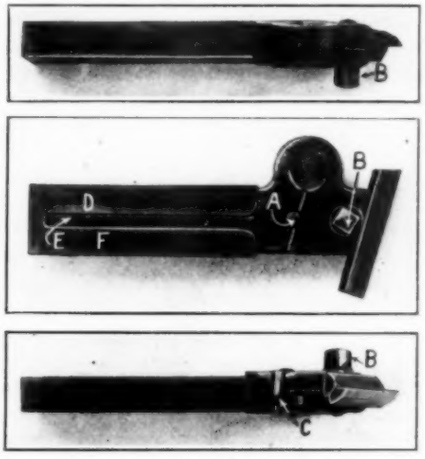
While this was evidently designed for automobile tool kits, it should be equally convenient for any mechanic, especially on repair work, as there are many places where such a tool will be found extremely useful. It is made up of drop forgings and will probably stand fully as much as any wrench of this size should be called upon to do. It is made by the Bemis & Call Hardware and Tool Company, Springfield, Mass.

A Threading Tool

The half-tones show three views of a new threading tool. The part *D*, which is clamped in the tool post is bored to fit the shank *E*. *E* is prevented from becoming detached by the pin *F*. This arrangement permits the tool to be swung over to suit the angle of the thread being cut. The tool is either of the solid or spring type at will, the insertion or removal of the pin at *A* accomplishing this object. At *C* on the bottom of the tool is a small tongue secured in one side of the spring slot and a sliding fit on the other side. This permits the tool to spring on end, but effectually prevents any side spring.

The cutter shown permits threads to be cut up to a shoulder, but for ordinary work a plain triangular piece of steel is inserted in the dovetail clamp and secured by the clamping screw *B*.

These tools are made by William Avery & Co., Foxboro, Mass.

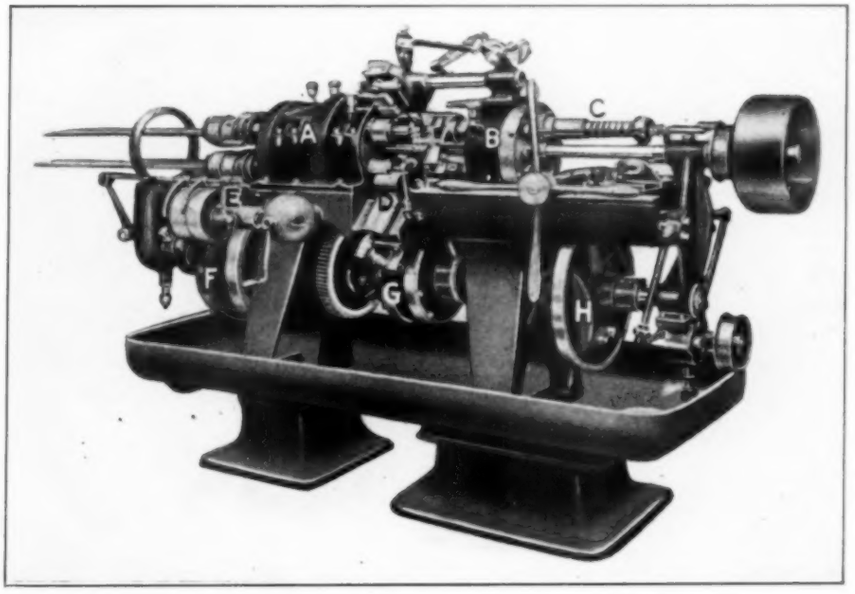


A THREADING TOOL

Simplex Four-spindle Automatic Screw Machine

This machine is of English origin, but is to be built in this country by the Boston Bolt Company, 40 Farnsworth street, Boston, Mass., for the American market. The head *A* carries four spindles, through which the stock is fed in the usual way and which turns after each operation so as to bring the next tool into play. These are held in the stationary turret *B*, while the threading is done by spindle *C*. There is no reversal of the work in threading, which is accomplished by revolving the tap or die faster than the work, while the backing-off is accomplished by stopping the die and letting the work unscrew from it.

There are cutting-off or forming slides on each die, the front slide being shown at *D*. At E is a small handle which stops the machine instantly should this become necessary, while *F*, *G* and *H* are the cams for operating the chuck, the cross-slide and the tool turret, respectively.

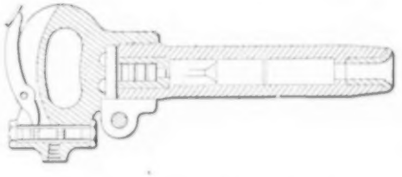


AUTOMATIC FOUR-SPINDLE SCREW MACHINE

The Helwig Pneumatic Hammer

The valve mechanism of this hammer is very simple. The valve is balanced, of piston type, and of large wearing surface. It is made of solid tool steel, hardened and ground. The valve chamber—one piece—of simple and substantial construction, hardened and ground, is imbedded firmly in the barrel and cannot displace itself, although readily removable.

The hose connection being located at



HELWIG PNEUMATIC HAMMER

right angles with the barrel makes it convenient to handle the hammer, as there is not so much pull of hose on the operator, and the hose being out of the way permits working in close quarters.

A simple locking device prevents the handle from getting loose, doing away with the annoyance of loose handles. The speed of the hammer can be regulated, and it will not operate unless the chisel is in place. As an illustration of the power of this hammer, a 4-inch stroke chipping hammer equipped with a rivet set, will drive ¾-inch rivets steam-tight. They are made by the Helwig Manufacturing Company, St. Paul, Minn.

File Handles That Do Not Split

This handle has been devised to do away with the annoyance of file handles splitting, with the attendant cost and danger to the user. This is secured by forcing a thin steel tube as long as the file shank into the handle, the end of this being turned over so as to hold the outer ferrule in place. There are no more metallic parts that can come in contact with the hands than in the ordinary handle, while this steel-tube reinforcement makes them very much more durable, in fact almost indestructible with ordinary use. While file handles are small details of shop equipment, yet the time lost in replacing split handles may amount to considerable in a year and the removal of one cause of painful if not dangerous accidents, is to be commended. They are made by J. L. Osgood, Buffalo, N. Y.

"INDESTRUCTIBLE" FILE HANDLE

Internally Fired Continuous Furnace

This furnace is formed of a steel cylinder, with a smooth fire-tile lining of helical form and is rotated upon a roller supported by a suitable iron frame. The power may be furnished from a line shaft or from a motor suitably controlled. Ordinarily the speed is from one to three revolutions per minute and the time of travel through the furnace from three to ten minutes. Either oil or gas may be used as fuel and it is injected directly into the chamber in the opposite direction to that of the travel of the material. Combustion is complete, and the spent gases find vent where the material enters, using up the heat to warm up the material in a gradual manner. The material is charged into the feed drum in bulk and is fed by the worm or thread through the furnace at a perfectly uniform and positive speed. The time and temperature for every piece is absolute. Starting cold the material winds its way through the convolutions of the furnace for a distance of about 47 feet, ever tumbling over itself, ever on a new hot surface, ever in the direct heat, yet only reaching its ultimate heat at the very point of discharge, where a pyrometer is so located as to show exactly what that ultimate heat is.

A lot of 15,732 pieces of steel was run through one of the furnaces, here shown, and hardened in oil and each piece was then carefully tested. Only two were found imperfect, and they from flaws in the steel itself, not from the heat. The manufacturer stated that such runs were the rule, not the exception. Again, material annealed in this type of furnace in 6½ minutes was found to be cleaner and better in every way than the same material annealed for 45 minutes in a tumbling barrel type of furnace. This would seem to prove that protection from oxidation and saving of time are both effected when the material is heated up gradually, never overheated and discharged the moment it has reached its ultimate temperature.

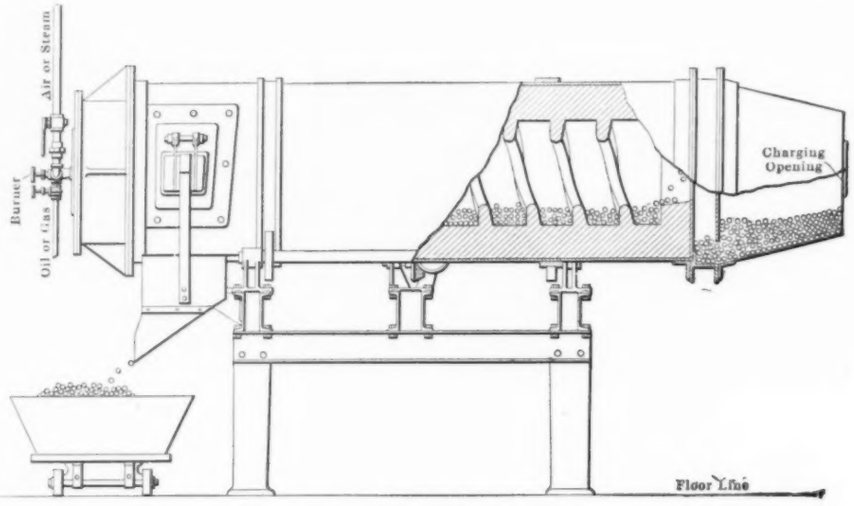


FIG. 2. SECTIONAL VIEW OF FURNACE

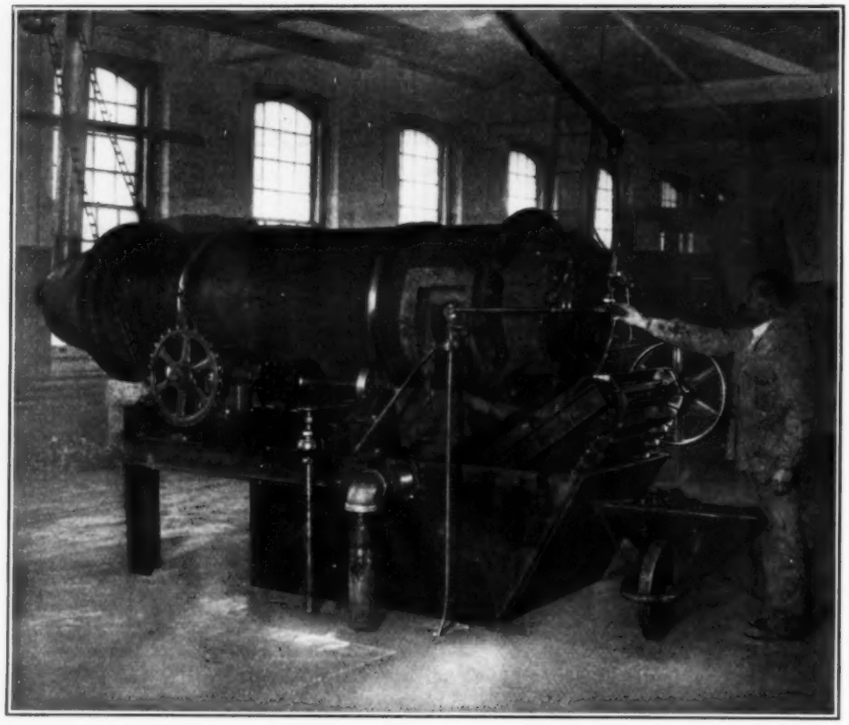


FIG. 1. FURNACE WITH CONVEYER FOR DISCHARGING THE HARDENED PIECES OF WORK

For Hardening

When the furnace was used for hardening a quenching tank with a conveyer was provided below the discharge spout so that the material, after immersion, was automatically removed from the bath quite clean and delivered into a truck or wheelbarrow. Provision was made so that two kinds of material could not become mixed; nor could any lodge in any part of the furnace or bath. By the simple removal of two bolts the conveyer could be easily removed from the bath, giving free access to every part thereof for cleaning or other purpose. The furnace requires no chimney, although a hood to carry off fumes from the oil bath or from machine oil on the material is sometimes desirable. Either air or dry steam may be used to inject the oil or gas fuel.

One of the chief features of the in-

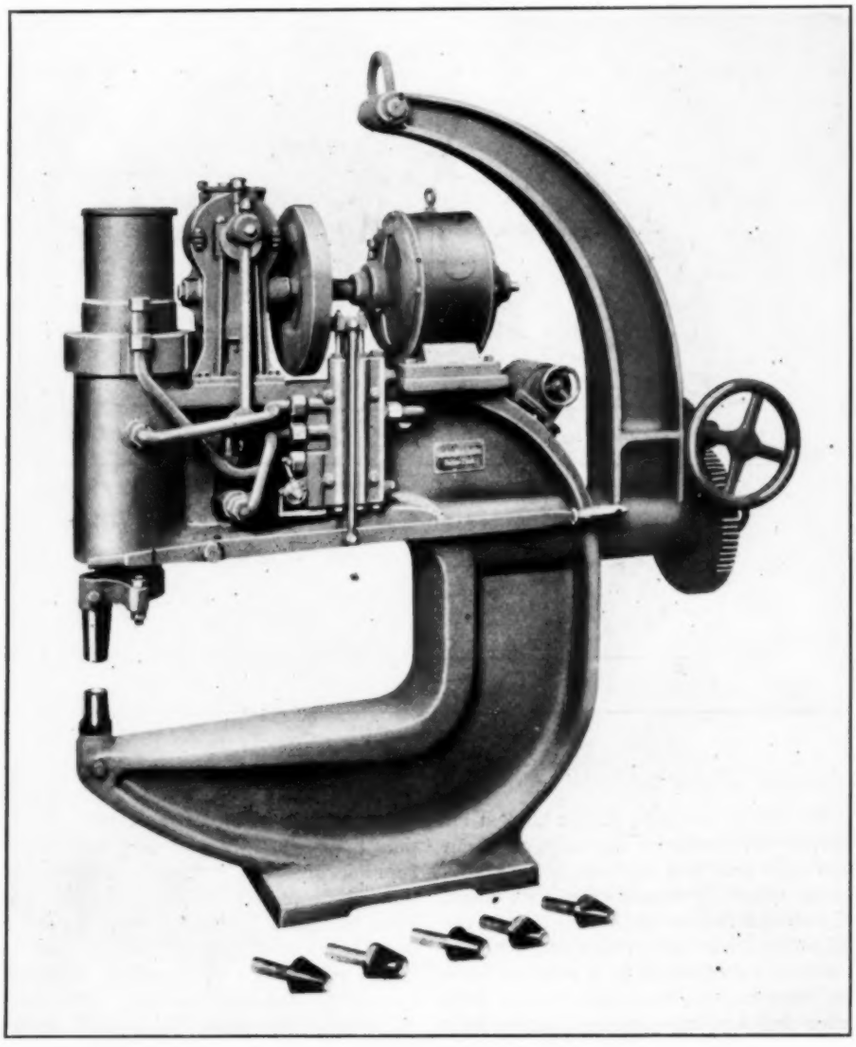
ternally fired helical furnace is its durability. Practically all the iron work is out of range of the fire, and all the parts are simple and strong. This makes an almost automatic hardening or annealing furnace, which insures the uniform heating of all the pieces and which can hardly fail to greatly reduce the cost of such work to a marked degree.

It is manufactured by W. S. Rockwell Company, 50 Church street, New York.

Another Electro-Hydraulic Riveter

This machine, while on the same general plan as the one recently illustrated, is operated in a somewhat different manner as will be seen from the illustration. Instead of securing the hydraulic pressure by forcing a plunger down with a screw, this motor drives the small hydraulic pump near the head of the machine through a worm and worm wheel, steadiness being secured by the small flywheel shown.

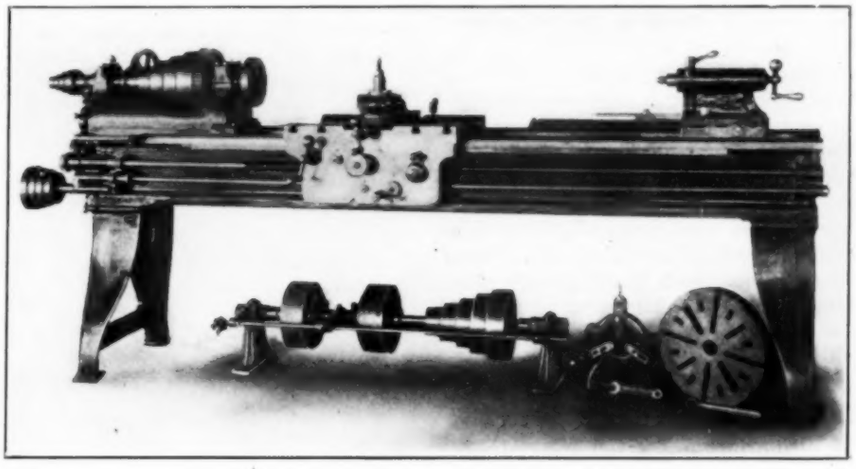
In other respects this machine is very similar to the one previously illustrated and needs no further description. We are indebted to Dr. Alfred Gradenwitz, of Berlin, Germany, for the information concerning it and it is made by Maschinenfabrik Oerlikon, Oerlikon, Zurich, Switzerland.



ELECTRO-HYDRAULIC RIVETING MACHINE

Miami Valley 15-inch Engine Lathe

The accompanying illustration shows an addition to the line of tools made by the Miami Valley Machine Tool Company, of Dayton, Ohio.



MIAMI VALLEY 15-INCH ENGINE LATHE

While called a 15-inch lathe, its actual swing over the bed is 16½ inches. The carriage is of T-slot design, gibbed both front and back, and provided with a chasing dial, by the use of which threads may be cut without reversing or stopping the lathe. Threads having pitches from 5 to 40 per inch, including 11½ per inch pipe threads, may be cut. The feeds are reversible in both head and apron and are so arranged that it is impossible to throw in the screw and rod feeds at the same time. The geared feed is positive and is obtained by engaging a gear on the lead screw with a gear on the feed rod. There are also four belt feeds ranging from 50 to 150 per inch. The lathe is regularly equipped with a compound rest, although a plain rest will be provided if desired. The tailstock is fitted with a No. 4 Morse taper in the spindle, is of the set-over and overhanging design, permitting the compound rest to be swung parallel with the bed. The crucible-steel spindle has a 1⅜-inch hole, and runs in phosphor-bronze bearings of which the front one measures 2⅝x4 inches, while the rear one measures 1 11/16x3 inches.

The National Metal Trades Association

Announcement has been made that the annual convention of the National Metal Trades Association will be held at the Hotel Astor, New York, April 14 and 15. The commissioner reports that the convention will probably be one of the largest ever held by the association.

The Cincinnati Bickford Tool Company

Announcement is made that a new corporation bearing the above title has been formed to acquire the business of the Bickford Drill and Tool Company and of the Cincinnati Machine Tool Company. The capital stock is to consist of $350,000 of common and $150,000 of preferred stock, stockholders of both the old companies taking the stock in the new. The new company is to build at once an entirely new plant at Oakley, the new manufacturing suburb of Cincinnati, and as neighbors of the Cincinnati Milling Machine Company, the Cincinnati Planer Company, and the Triumph Electric Company. August H. Tuechter, president of the Cincinnati Machine Tool Company, will be president of the new company.

Cutting-off and Centering Work

Centering work to be turned is such a simple operation, the first given to the boy or learner of more mature years, that we are too apt to consider it of but little importance as long as the reamer used is the same angle as the lathe centers.

But there is another condition which is very important where duplicate work is to be turned in large quantities and that is the depth of the center reaming. With pieces cut off exactly to length, this can be readily governed by a simple stop collar on the reamer or other device, but when the pieces vary in length up to one-sixteenth of an inch it becomes more of a proposition. When the work is faced to a standard length after such a discrepancy as this there is a decided difference in the appearance of the centers. Nor is this the worst feature, for where the work has one or more shoulders, as is usually the case, the location of the stops for the various tools is pretty sure to become something of a problem.

One solution of the centering difficulty is to have the drilling and reaming of the last end depend on the length of the piece, gaged from the first end. Where the first end has been countersunk to a given depth and this end is placed in the same position in each case, the shoulder stops can be set from that end and the facing to length done at the other end.

Another method, as in the case of the Lo-Swing lathe, is to mount the stops on a bar which can be moved to suit the piece in the machine, and fitted with a gage which acts against the end. A little care in cutting to within a much closer limit than is usual would do away with the necessity of most of these remedial operations that follow.

Indicator Cards from Variable-volume Air Compressors

By H. V. Haight*

The cards shown herewith are from the air compressor described in the American Machinist, Vol. 31, Part 1, page 679.

It will be recalled that the machine shown was a 25x16x36 duplex-tandem air compressor, having a capacity of about 3400 cubic feet, and driven by a 600 horsepower motor by means of a rope drive. The special feature of the machine is the unloading device by which one-quarter of the load is thrown off at a time, by holding open one high-pressure Corliss inlet valve and one low-pressure Corliss inlet valve at each step. In reality the low-pressure Corliss valve is held open slightly before its corresponding high-pressure valve. This makes the unloading and the taking up of the load again come in practically eight steps and allows a little drop in the intercooler pressure between the four regular steps. This is well shown in Fig. 5 where the low-pressure cylinder is taking up its load.

It is hardly necessary to point out that these cards show almost perfect valve action both when compressing and when running unloaded. Further evidence of the very complete unloading of the machine is shown by the fact that the starting current, required for the alternating motor which runs the machine, does not exceed the full-load current. The completeness of the unloading as well as the very small friction of the motor, rope drive and compressor is also shown by the

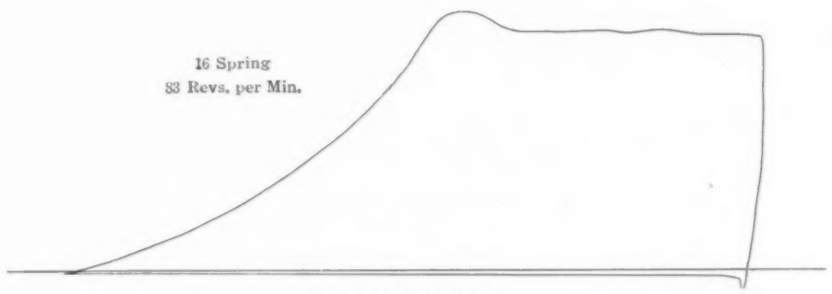


FIG. 3. Compressing

Left Crank, 16 Spring, 83 Revs. per Min.

FIG. 4. Unloaded

LOW-PRESSURE CYLINDER CARDS

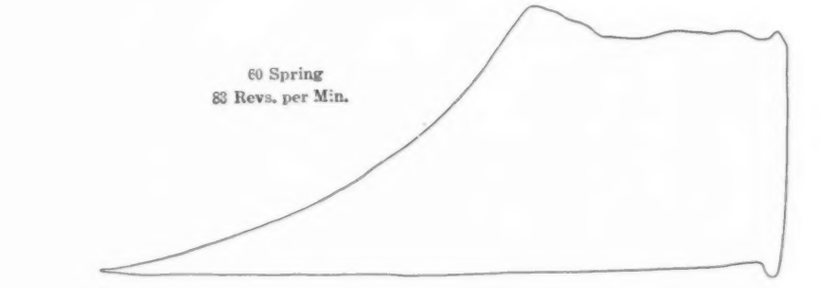


FIG. 1. Compressing

Left H.P. Crank - 60 Spring

FIG. 2. All Unloaded

HIGH-PRESSURE CYLINDER CARDS

*Chief engineer, Canadian Rand Company, Ltd.

fact that the machine will run six minutes after the current is cut off.

The action of the unloader in maintaining steady air pressure is shown by the recording-gage diagram, Fig. 6. It will be seen that the machine is shut down from noon to 1 p.m., from 6 to 7 p.m. and also from 1 a.m. to 7 a.m. From 1 p.m. to 6 p.m. the machine is often overloaded, probably on account of opening up an air pipe to blow away the smoke from blasting. Except when overloaded or shut down the pressure is maintained at 97 to 100 pounds; the maximum variation does not exceed three pounds.

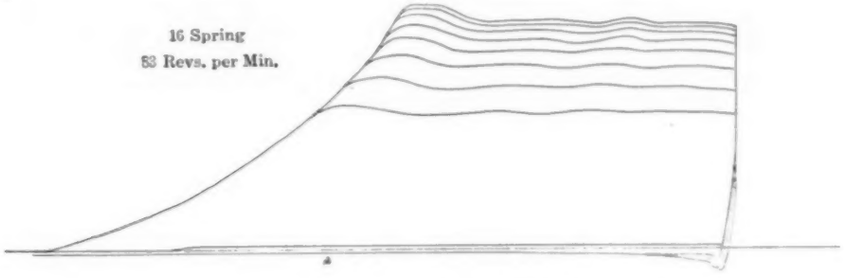


FIG. 5. LOW-PRESSURE CYLINDER PICKING UP LOAD

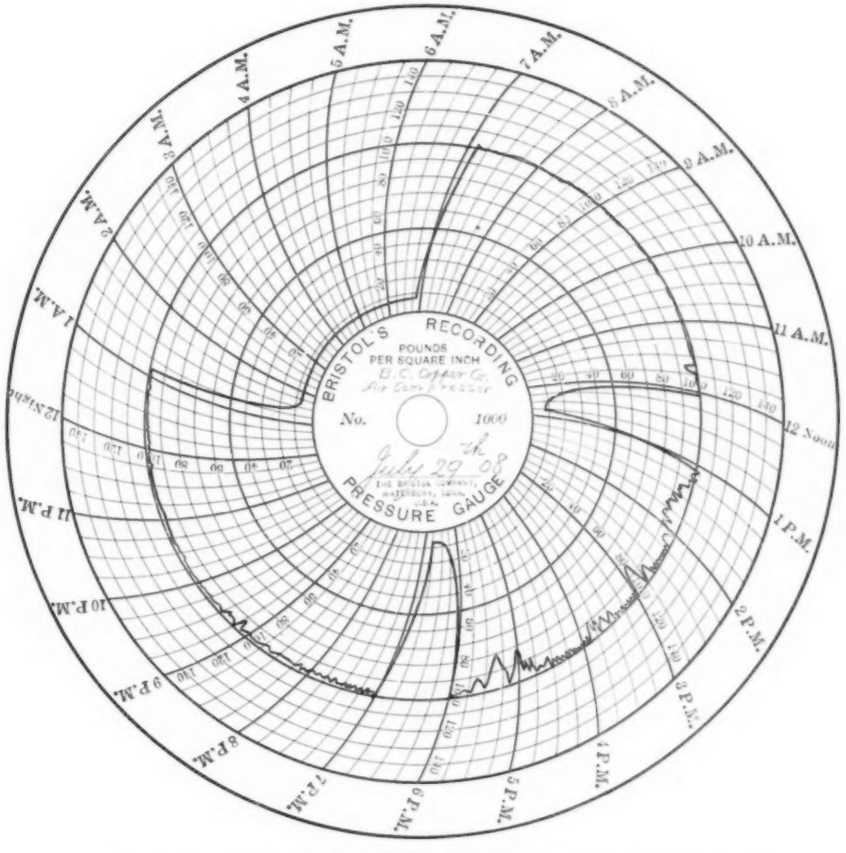


FIG. 6. PRESSURE-GAGE RECORD FOR VARIABLE-VOLUME AIR COMPRESSOR

To find the weight of castings, multiply the cubic inches by 0.27 for iron, 0.29 for steel and 0.30 for brass.

Three Special Tools

By Ethan Viall

Some time ago I was in a small shop where they were making gasolene engines and the man who was finishing up the pistons was using two Armstrong tools for turning out the piston-ring grooves. One holder had an ordinary cutting tool in it which was ground slightly narrower than the finished groove. This tool was used for roughing, while the other holder had a tool in it similar to Fig. 1, which was made by taking a piece of annealed high-speed steel and drilling a hole through it and reaming it out for a No. 0 taper pin. It was then split by sawing a slit in it as shown. The tool was then hardened, and he had a finishing tool with considerable range of adjustment and which could be touched up on the emery wheel by hand and then brought to the exact size wanted by tapping in the pin and sizing with a micrometer.

This same shop was making a jig into which it was intended to put a small stationary gasolene-engine cylinder and do all the machining necessary on it in a drill press, before it was removed from the jig. The cylinder was 3½-inch bore and was to be bored out with a special boring bar working through a bushing in the jig. The final reaming was to be done by inserting another bushing in the jig and using the reamer shown in Fig. 2. This reamer consisted of a machine-steel body into which were set four tool-steel blades as shown. All the cutting was to be done at the front edges or corners, the part of the cutters which were set into the body being ground to a running fit in the jig bushing.

How this tool worked in practice I never learned, but it looked to me as if, since there was no clearance the long way of the blades, metal would work in on top and score the work.

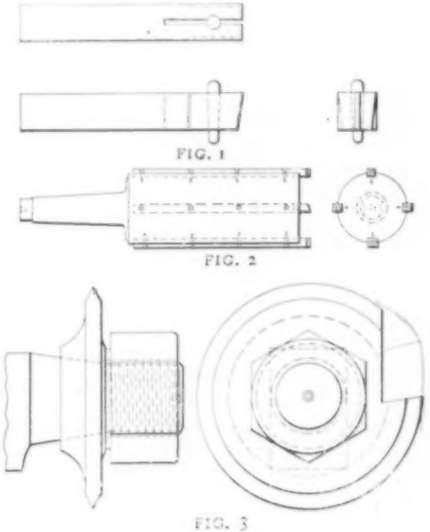


FIG. 1

FIG. 2

FIG. 3

THREE SPECIAL LATHE TOOLS

In another shop doing a good deal of internal thread cutting on large pipe, they use a tool like Fig. 3. The body of the holder is machine steel, the nut is case-hardened, and the circular thread tool is made of carbon steel, high-speed steel of various kinds having been tried with poor results on their work. The tool is kept from turning by the taper friction when forced on by the nut, the body of the cutter being rather heavy to resist bursting.

The amount of timber cut last year from all the national forests of the United States was 302,792,000 feet, board measure, as against 194,872,000 feet in the previous year. This figure for 1908 does not include the 131,482,000 feet given away to settlers, schools and churches under "free use" permits.

Convention of the American Anti-Accident Association

The first annual convention of the American Anti-Accident Association was held in the Twenty-third street Y. M. C. A. building, New York City, on February 11, 1909, with both an afternoon and an evening session. President West presided at both meetings.

The purpose of this convention was to call attention to the work of the association and to broaden its sphere of usefulness. In the afternoon four papers were presented: The Status of the Railroad Employee in Regard to Accidents, by J. O. Fagan; Hoodlumism in Holiday Observances, by Mrs. Isaac L. Rice; Fire Wastes Through Carelessness, by C. M. Goddard, president of the National Fire Protective Association; and Excessive Speed the Cause of Many Accidents, by G. J. Miller.

In Mr. Fagan's paper he laid many, in fact most, railroad accidents to the door of the railroad employees; in distinction to the usual position of blaming the corporations alone. Mrs. Rice, president of the Society for the Suppression of Unnecessary Noise, laid especial stress on the accidents from fireworks and other agents used to celebrate the 4th of July, Election day, and other holidays. The restriction of such celebrations is one of the ends toward which Mrs. Rice's society is working, as well as one of the purposes of the anti-accident association.

At the evening session President West outlined the fundamental purposes of the association under 24 heads, of which the following are applicable to the machine-building industry: Obtaining information of the true underlying causes of accidents. Advocation of consistent hygienic or sanitary science in our nation's educational, commercial and industrial institutions. Contention for the installing of practical safety devices wherever such may reduce the risk of accidents. Vigorous efforts to help reduce the present appalling number of fires in our forests, dwellings, commercial and industrial communities. Enactment of plain, concise laws that will provide fines and imprisonment for careless neglect of duty, endangering life and property, on the part of the individual and corporation alike.

Director W. H. Tolman, of the American Museum of Safety and Sanitation, presented the work of European museums of safety devices, showed what his own institution had done and was doing and outlined briefly the plan for a permanent museum in New York City, housed in a suitable building built and adapted for its needs. This lecture was illustrated by numerous lantern slides and was very well received.

Four pertinent papers followed: Our Shameful Lead in Railway Accidents, and the One Sure Method of Checking it, by Edward Bunnell Phelps; An Analysis of 5500 Machine-shop Accidents, by L. P. Alford; Safety Devices in Machine Shops and Manufacturing Establishments, by Prof. John E. Sweet; and Preliminary Report of the Committee of the American Foundrymen's Association on Prevention of Accidents in Foundries, by Dr. Richard Moldenke, secretary of the Foundrymen's Association.

Mr. Phelps recommended and urged that the method to be used in checking railroad accidents is to develop a public demand, a demand from the great traveling public, that the number of railway accidents must be minimized. The railway corporations are in business to cater to the demands of the public in as cheap a way as they can; when any such demands become insistent they are met. It is a well known fact that in England the percentage of railroad accidents is far less than here. When the time is ripe to consider safety appliances, and that time is now, a nonpartisan expert commission should be appointed to study English railroad conditions and to determine what devices and methods there used can be adopted here with profit.

Professor Sweet's and Mr. Alford's papers were printed entire in our last week's issue of the AMERICAN MACHINIST, commencing on pages 218 and 209, respectively; therefore, they need no comment in this brief report.

Dr. Moldenke's report was based on the returns from a circular letter sent to every foundry in the United States and Canada. In all 6366 inquiries were sent out; 1084 replies were received, or 17 per cent. These detailed 5242 accidents of various kinds under the classes indicated in the information blank. A summary of the totals is shown in the accompanying table.

Accident Due to:	Slight.	Serious.	Fatal.	Total.	No. Reporting.	Loss in $.
1. Personal carelessness	1,974	140	4	2,118	123	$10,106.39
2. Careless work	516	39		555	33	4,643.25
3. Inattention in shop	227	23		250	19	612.00
4. Intoxicants	4	3		7	4	33.00
						and 1 foundry
6. Unavoidable accidents	1,547	159	3	1,709	90	6,858.35
7. Neglect of safety devices	83	7	1	91	9	702.00
8. Disobedience of orders	79	12	2	93	20	3,531.50
9. Taking chances	118	24		142	27	2,093.18
10. Inferior materials used	24	4		28	5	123.25
11. Employee's ignorance	235	13	1	249	15	1,135.50
	4,807	424	11	5,242	345	$29,838.42 and 1 foundry

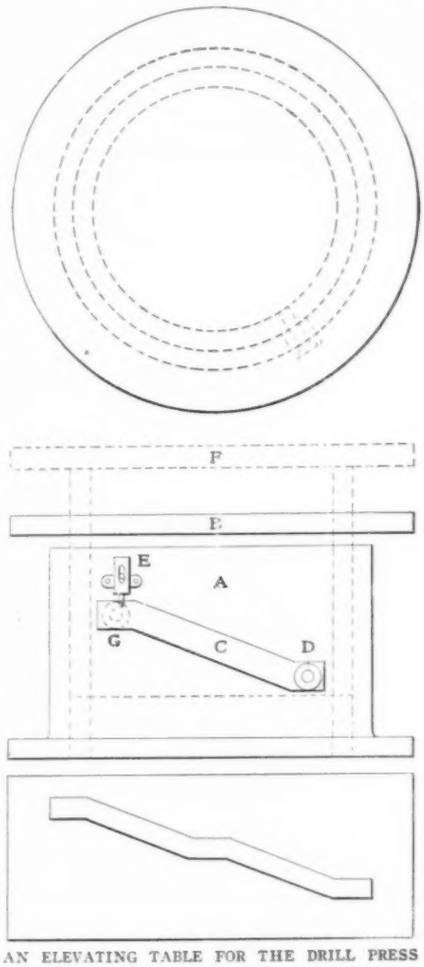
The final report, of which this is but one section, will present an analysis of the safety devices that were suggested to prevent the accidents that were reported.

The attendance at neither session was large, but was composed of persons interested in the work and movement. Mr. West deserves commendation for the efforts that he is putting forth through the medium of this association.

An Elevating Table for the Drill Press

BY E. A. DIXIE

We once had a job for the drill press where the traverse of the spindle was not sufficient and for which I made the fixture shown in the line cut. *A* and *B* were two pieces of cast-iron pipe with flanges on them, resurrected from the scrap heap. The flanges were faced first and then *A* was bored and *B* turned a sliding fit in *A* after which *A* was mounted on the milling machine and the spiral slot *C* was cut with an end mill. This slot had a land at each end parallel with the



AN ELEVATING TABLE FOR THE DRILL PRESS

face of the flange. A stud and roller *D* were fastened in *B* when inside of *A*. To the outside of *A* was secured a small casting *E* fitted with a spring plunger which locks the roller *D* when at the position *G*. When the holes in the work are finished with the table in the position *B* the edge of the table is grasped by the hands and it is swung around till the roller *D* is in the position *G*. This raises the table to *F* the distance *B* being governed by the pitch and length of the slot *C*. Where jigs are used which handle work in which three hights or depths of hole are necessary there can be two slots *C* with a land *G* between them and a land at the top as shown in the bottom cut.

Probably three grooves 120 degrees apart with three rollers might be considered better practice but the job was in a hurry, one groove proved perfectly satisfactory, and three grooves would have increased the cost considerably.

Business Items

The factory, equipment and all assets and liabilities of the Massnick Manufacturing Company, of Detroit, Mich., have been taken over by the Michigan Auto Parts Company, of that city, which latter company are installing additional machinery and equipping a large drafting room. The management will remain unchanged.

The Taylor Machinery Company has recently started operations for the sale of general lines of machinery at 8 Oliver street, Boston, Mass. Thomas Irving Taylor, who was connected with the Boston office of Manning, Maxwell & Moore a few years ago, and later with the Chicago office of the Sprague Electric Company, is manager of the concern.

The Crocker-Wheeler Company, of Ampere, N. J., has just closed a contract to equip with motor-drive the new woodworking factory of the John Hofman Company, Rochester, N. Y. The order includes 40 induction motors ranging from 1 to 30-horsepower, with a total capacity of about 200-horsepower. These motors will be used for individual drive, each machine being equipped with its own motor. The motors, with the exception of one, are of the squirrel cage type. The generator for this plant and three lighting transformers are also included in the order placed with the Crocker-Wheeler Company.

Business Opportunities

The Toronto (Ont.) Show Case Company will erect a factory.

William Horn, of Maurice, La., will establish machine shop in Abbeville, La.

J. D. and Wm. Stone, Irvine, Ky., will establish sawmill at Ironmound, Ky.

The Standard Adding Machine Company, St. Louis, Mo., is erecting a new plant.

Kincaid Lumber Company, Statesville, N. C., will establish planing mill at Mocksville.

The Standard Meter Company, Philadelphia, Penn., is having a new factory erected.

The Washington Parlor Furniture Company, Tacoma, Wash., will erect a new plant.

The American Machine Company, Detroit, Mich., is negotiating to move to Elwood, Ind.

A two-story machine shop will be erected for the Disston Saw Works at Tacony, Penn.

The plant of the Fowler (Colo.) Canning Company, which burned some time ago, is to be rebuilt.

W. H. Penman, Beaumont, Texas, has purchased site on which to erect iron works and foundry.

Starr's Lumber Company, of Chattanooga, Tenn., contemplates establishing box factory at Etowah.

The plant of the American Tubular Axle Company, Toledo, Ohio, was destroyed by fire. Loss, $75,000.

The Pioneer Pole and Shaft Company, of Piqua, Ohio, will locate in Cairo where new plant will be erected.

The Endebrock Trunk Company, St. Joseph, Mo., will erect a new trunk and suitcase factory: also box shop.

Work has been started on the new factory for the Coulter & McKenzie Machine Company, Bridgeport, Conn.

The Swift-Waters Company, Berlin, Conn., manufacturing hardware specialties, is erecting a new factory building.

The Union Metallic Cartridge Company, Danbury, Conn., is planning the erection of a ten-story factory building.

The Gerlinger Steel Casting Company, West Allis, Wis., has purchased ground on which a foundry will be erected.

The planing mill of the Kansas City (Kan.) Wagon Wood Stock Company was burned, causing a loss of $10,000.

The machine shop of the Cast Thread Foundry and Fittings Company, Seneca Falls, N. Y., was burned. Loss, about $80,000.

Shiman Bros. & Co., of New York, is having a factory erected in Newark, N. J., where high grade jewelry will be manufactured.

The repair shop of the Boston & Northern Street Railway Company at Melrose, Mass., was destroyed by fire. Loss, $35,000.

The Rudgear-Merle Company, of San Francisco, Cal., manufacturer of brass and iron beds, will establish a branch plant at Portland, Ore.

O. L. Barringer, Charlotte, N. C., will erect garage which is to be equipped with electrically driven machines for repairing automobiles, etc.

The Brooks Tire Machine Company, Wichita, Kan., has bought site on which plant for the manufacture of its cold tire setter will be erected.

The Deemer Steel Casting Company, New Castle, Del., incorporated with $200,000 capital has purchased site for plant, which will employ 150 hands.

The Gibb Spring Motor Tire Company, Little Rock, Ark., recently incorporated, has commenced construction of plant. Fred. Newton Gibb, president.

Eastern Iron and Supply Company, Bartlesville, Okla., a new concern, will erect building and install pipe-cutting and threading machines. H. L. Levy, president.

The M. M. Buck Manufacturing Company and the Handlan-Buck Company, Chicago, Ill., manufacturers of railway supplies, are erecting a new plant, which will cost about $300,000.

W. C. Dehaas, of Hamburg, Iowa, has purchased site in Wichita, Kan., on which to erect a canning factory. Mr. Dehaas is interested in the Riverside Canning Company, of Hamburg.

The Yellow Pine Paper Company, Orange, Mass., will triple capacity of plant. New machinery will be installed, including digesters, rotary furnaces, conveying machinery, engines, etc.

The Broughton Bolt Company, Cleveland, Ohio, capitalized at $50,000, is looking for a site for plant for the manufacture of bolts. John S. Broughton, J. J. Becker and others are organizers.

The Moran Company, Seattle, Wash., has been awarded contract by the James A. Moore Investment Company for construction of a complete steel plant at Irondale, near Port Townsend.

The Isthmian Canal Commission, Washington, D. C., will receive bids until 10:30 a.m., March 1 for boiler tubes, shafting and drop hangers, power hack saw, band saws, lathe chuck, taps, machinists' hand dies, etc., as per Circular No. 494.

New Incorporations

The Toledo Packing Company, Toledo, Ohio, has been incorporated with $400,000 capital by F. J. Reynolds, J. C. Reinhart and others.

The Wilson Paper Box Company, Richmond, Va., incorporated with $25,000 to manufacture paper boxes. Incorporators, A. H. Drewey, W. H. Mattox, E. L. Harmen.

The Emil Grassman Company, New York, has been incorporated to manufacture automobiles, etc. Capital, $100,000. Incorporators, E. Grassman, J. Silverman, J. A. Vesey.

McGirr Manufacturing Company, De Kalb, Ill., incorporated to manufacture wagons and machinery. Capital, $10,000. Incorporators, John McGirr, P. A. McGirr, J. A. Dowdall.

The Whalen Lock Company, Jersey City, N. J., has been incorporated. Capital, $100,000. Incorporators, H. W. Partridge, J. T. Whalen, A. I. Drayton. Will manufacture locks, etc.

The Lincoln Agricultural Iron Company, Rockaway, N. J., has been incorporated with $25,000. Incorporators, F. P. McIntyre, J. E. Neylon, Jas. V. Beaum. Will manufacture iron steel, etc.

The Perth Amboy Hardware Company, Perth Amboy, N. J., incorporated with $100,000 capital. Incorporators, S. R. Farrington, M. P. Madson, Franz Neilson. Will manufacture hardware, specialties, etc.

Wood Printing Plate Machine Company, Jersey City, has been incorporated with $200,000 capital. Incorporators, H. O. Coughlan, T. A. Anderson, J. R. Turner. Will manufacture printing machinery.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

For heavy engineering specialties to manufacture on royalty. Box 878, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Engine lathe, 24" to 28"x14' or more; also 14" to 16"x8' or more. Box 930, AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Special machinery designed, new ideas developed to practical results. Detail drawings made. Prices reasonable. Box 920, AM. M.

Wanted—A 50 to 60" boring and turning mill, two heads preferred. State best cash price, condition and how long in use. Address F. X. Hooper, Glenarm, Maryland.

Machinery designed and improved by technical expert; graduate electrical and mechanical engineer. Working drawings, patterns and castings furnished. R. P. Clarkson, Beverly, Mass.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

I desire to purchase an interest in a business making machinery and castings, and take the superintendency of the plant or entire management of the business. I am thoroughly well qualified by experience, reputation and ability to produce profitable results. Address Box 936, AMER. MACHINIST.

In order to settle an estate an attractive opportunity is open to a party with $150,000.00, competent to fill responsible position either in the sales or manufacturing department, to purchase an interest in a well and favorably known, profitable machinery manufacturing plant located in Pennsylvania, with an office and established trade in New York City. Address "Executors," care of AMERICAN MACH.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Mechanical engineer, member A. S. M. E., expert on highest grade interchangeable work, 25 years' experience. Competent manager, superintendent or chief engineer. Experience embraces manufacture of automobiles, typesetting machines, firearms and typewriters. Box 913, AMERICAN MACHINIST.

CONNECTICUT

A firstclass, all-round machinist and grinder, experienced on Landis, Norton and Brown & Sharpe grinders, desires to hear from any automobile concern whomay offer the chance in building and repairing up machines thoroughly. Box 940, AMERICAN MACHINIST.

ILLINOIS

Tool room foreman desires change; first class on tools for adding machines, cash registers and typewriters. Box 764, AM. MACH.

INDIANA

Superintendent—Practical machinist and toolmaker. Wide experience handling men and producing results. Age 38. Now employed. Will go anywhere. Box 877, AMER. MACH.

Foreign representative—Competent mechanical engineer, German technical graduate, desires position as special European representative for American machine or tool firm; wide experience in machine tools and familiar with European business. Box 941, AMERICAN MACHINIST.

MASSACHUSETTS

Automatic screw machine foreman desires change; can get quality and quantity from multiple as well as single-spindle machines; if interested, address "Automatic," AM. MA.

Engineer, experienced in the development of gas engines and allied industries, wishes to correspond with progressive small shop. Ability proved by successful designs. Box 928, AMERICAN MACHINIST.

Graduate mechanical engineer, first class designer with excellent experience in steam turbines, pumps and general machinery, would like position as designing engineer or chief draftsman. References of well known concerns. Box 929, AMERICAN MACHINIST.

MICHIGAN

An experienced brass foundry foreman desires a position; 10 years' practice with molding machines, steam and plumbers' supplies; first-class references. Box 937, AM. M.

NEW JERSEY

Young, first-class mechanical draftsman desires change; resourceful and practical, special machinery. Box 924, AMERICAN MACHINIST.

Mechanical draftsman wants position, with growing concern preferred; experienced, first-class man in construction of small tools, special machinery, sub-press dies, etc. Address Box 899, AMERICAN MACHINIST.

An inventive, thorough, broadly experienced mechanic, practical toolmaker; an organizer, proven ability, wants change; responsible position. Reliable firms only. Box 622, AMERICAN MACHINIST.

NEW YORK

Automobile and gas engine designer with several years' experience, wants position. Box 933, AMERICAN MACHINIST.

Experienced mechanical draftsman, practical and theoretical, technical graduate, open for engagement. Box 932, AMER. MACHINIST.

General foreman, 25 years' experience, thoroughly acquainted with steam engine work and competent to handle men. "A. Z.," AMERICAN MACHINIST.

Superintendent or general foreman, experienced on special machinery and sheet metal stamping. Practical mechanic and good executive. West preferred. Box 903, AMER. MACH.

Superintendent of large experience in manufacturing line will be open for an engagement March 1. Good organizer, understands modern shop methods and cost reducing systems. Best of reference. Address Box 923, AMER. MACH.

Superintendent and designer of automatic machines and presses, capable of taking full charge of the building and manufacturing end of the business; fully conversant with the latest methods; at present employed as superintendent and designer but desire to make a change. Box 935, AMER. MACH.

Shop engineer, as present employed as such in large locomotive manufacturing shop, desires position as mechanical superintendent or chief engineer. Five years with present employers in charge of improvements and maintenance work and power houses. Have had general shop experience, and a technical graduate of leading engineering college. Age 32. Box 938, AMERICAN MACHINIST.

OHIO

Engineer of established reputation, wide experience apprentice to works manager, intimate knowledge of best shop and machine tool practice on heavy work, gilt-edged record, is open for engagement as works manager with full responsibility and can deliver the goods. Box 865, AMERICAN MACHINIST.

OREGON

Mechanical engineer, having 12 years' experience on gasolene engines will be open for a position after March 15 as superintendent or designer. Box 934, AM. MACH.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreign sales manager, desires position as latter at London, with A-1 American engineering firm. Thoroughly familiar with English and Continental business; up-to-date hustler. Box A.2, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent Wanted—Experienced in manufacturing and assembling adding machines, typewriters or small tools. Must be educated in mechanics, experienced and qualified to lay out and direct work and to handle men. Should understand factory organization, shop production and economy. Write, stating experience, place and date of birth and salary to go to Canada. Good opportunity and chance for advancement to a wide-awake, progressive man. Address "L. A. W.," care AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Two first-class patternmakers, experienced on engine work. Address Berkshire Pattern Co., Pittsfield, Mass.

NEW JERSEY

Wanted—Some first-class all round machinists, experienced on gas engine work. Apply Standard Motor Construction Co., No. 172-180 Whiton Street, Jersey City, N. J.

Wanted—Working foreman to take charge of 10 or 12 milling machines, turret lathes, and drill presses. A hustler, able to keep machines up to concert pitch. Good chance for young man wishing to advance. Box 927, AMERICAN MACHINIST.

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

NEW YORK

Wanted—Turret lathe hands and toolmakers. In replying state experience, references and wages required. The Georgian Manufacturing Company, Binghamton, N. Y.

Foreman screw department; operating hand and automatic machines; mostly short setups; no cinch. Steady job for the right man. Box 931, AMERICAN MACHINIST.

Wanted—Master boilermaker at $6.24 per diem. A competitive examination will be held at the Navy Yard, Brooklyn, N. Y., February 26, 1909, to fill the above position. For application and further information address, "Commandant," Navy Yard, Brooklyn, N. Y.

Engineer—We want a technical man for position as engineer of methods. One to do general experimenting and investigating on power apparatus machinery. Must be thoroughly familiar with shop methods and processes. In answer, state fully in detail your experience, age and salary expected. Your answers will be treated in confidence and should a personal interview be desired, it will be arranged for later. Box 904, AMERICAN MACH.

OHIO

Wanted—Man in Cleveland, Ohio, who thoroughly understands the manufacture of butt hinges. State where experience was attained and salary wanted. Box 922, AM. MA.

PENNSYLVANIA

Wanted—A first-class man as superintendent for a gear shop near Philadelphia, Penn. State experience and salary expected, where last employed and if willing to sign a year contract. Communications will be held as confidential. Address Box 925, AMERICAN MACHINIST.

Wanted—A machinist or a man having experience in gear cutting to cut gears on a Gleason planer. State fully your experience and length of time at the trade; also your age and wages wanted. Shop located in eastern part of Pennsylvania. Box 926, AM. MA.

Press department foreman; man wanted who is capable of taking charge of heavy and light stamping presses on a variety of high-grade sheet metal work and getting a quantity of work correctly done. A first-class position to a first-class man. Location, Philadelphia. Apply Box 939, AM. MACH.

For Sale

Valuable U. S. A. Patents—For sale outright or on royalty. Improved ball bearings well known in the auto and machine trade on the Continent. Deutsche Kugellagerfabrik G. m. C. H., Leipsig, Plagwitz (Germany).

A Bargain for $500.00—F. O. B. cars here a 500-horsepower tandem compound engine, 12"x20"x24" cylinder dimension, 170 r.p.m., fly-wheel 9'x16" face, ready to put on foundation to run; cost new $2000.00. Address Reinhold Bettermann, Johnstown, Penn.

For Sale—Well equipped general machine shop in New Jersey, employing 24 hands and now running 13 hours per day and with good prospects for the future. Good reason for selling. Investigation solicited. Address "R", Box 1216, New York City.

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Electric Welding in the Boiler Shop

Appliances Used in the Manufacture of Bath Boilers. Comparative Costs and Strengths of Riveted, Gas Welded and Electric Welded Seams

BY E. A. DIXIE

The business of making bath boilers is of considerably greater magnitude than the average layman would imagine. In support of this statement the John Wood Manufacturing Company, Conshohocken, Penn., turns out from 800 to 1000 boilers every twenty-four hours. In this plant very little reliance is placed on either secrets or patents. The principal protection against competitors is by keeping ahead of them, by installing special machinery and approved methods of production. The plant covers about 3½ acres of floor space on both sides of the Schuylkill Navigation Company's canal at Conshohocken, Penn., and has three lines of rails, two into the factory and one in front of it.

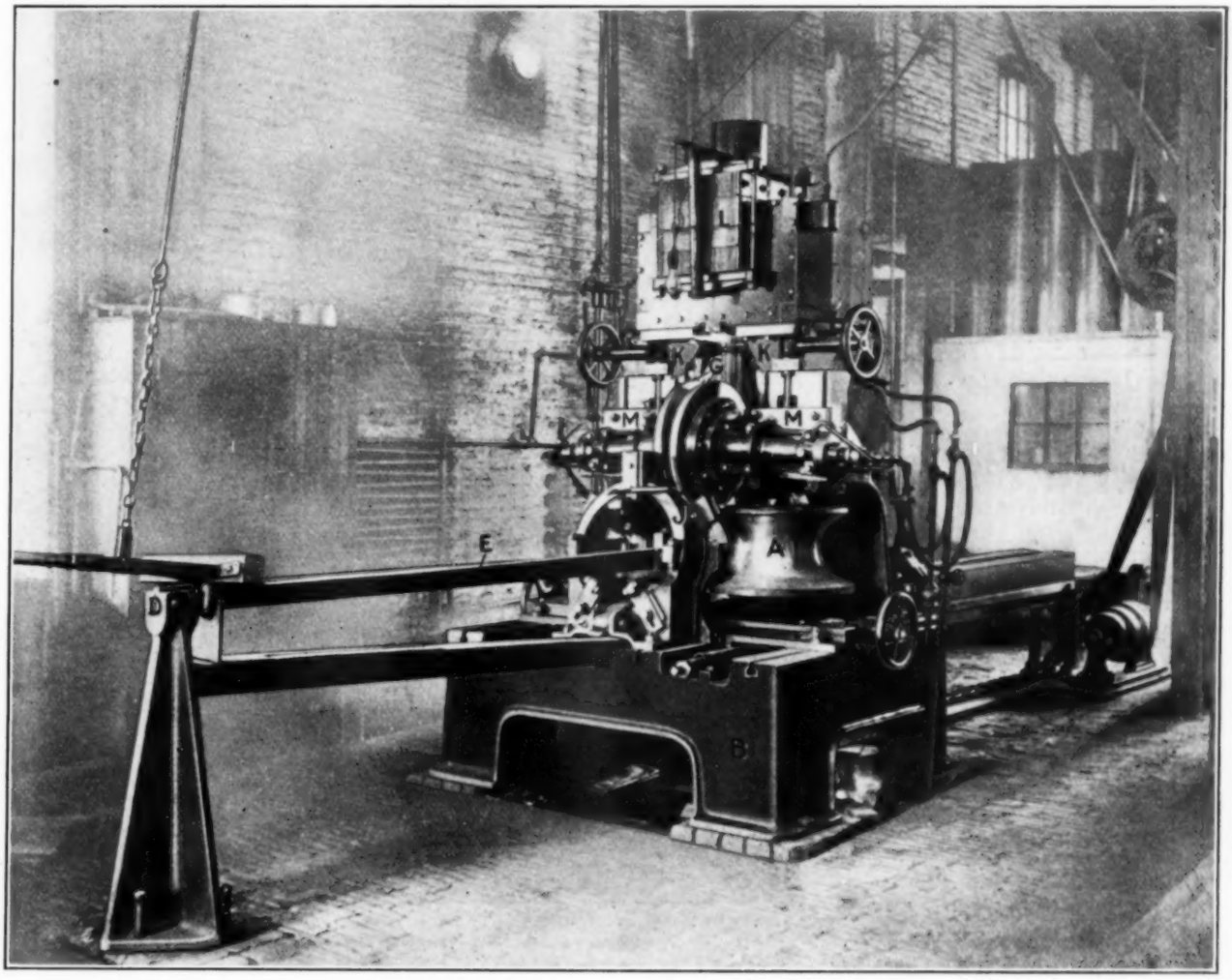


FIG. I. FRONT OF ELECTRIC WELDING MACHINE

The raw material in the shape of plates cut to size and varying in thickness from No. 16 to No. 9 Birmingham wire gage (these are the thicknesses of the plates used for the boilers having electrically welded seams) are manufactured in the same town to special analysis. The requirements for this purpose demand an open-hearth steel possessing anti-rusting properties. It must be low in carbon, the analysis calling for 0.12 per cent., and the sulphur content must not exceed 0.03 per cent. while the tensile strength varies between 55,000 and 58,000 pounds per square inch.

The first operation is the rolling of the plates into cylindrical form which is done on the usual boiler rolls which are, of course, of a diameter to suit the work, the boiler shells ranging in diameter from 7 to 16 inches and up to 70 inches in length. From the rolling operation the shells pass to the sand-blasting room where the usual low-pressure sand blasting apparatus is used to remove the scale back on either side of the seam for about an inch and a half. The object of this is to give clean metal free from scale for the weld and also to facilitate the passage of the electric current, scale being a partial insulator of electricity. The plant which supplies current for the two welding machines are two 60-kilowatt Thomson alternating generators, specially wound for the purpose, delivering the current to the primary circuit at a voltage varying from 250 to 350, heavier work requiring the greater voltage while for thinner work the primary voltage is reduced. The Thomson process of electric welding is used with modifications made necessary by this particular class of work. These modifica-

tions have been developed at this plant and are embodied in the two machines, built by the Standard Welding Company, Cleveland, O., shown in Figs. 1, 2, 3 and 4.

The machines are approximately 9 feet high, 6 feet wide and 20 feet long over all. The machine proper consists of a heavy cast-iron base *B* upon which are mounted the pressure rolls or spools *A* one on each side and between which the boiler shell *C*, Fig. 3, passes during the welding operation. These rolls are made in pairs for the various sizes of boilers, are easily changed from one size to another and are mounted so as to adjust to or from the center.

In front of the machine in a stake *D* which carries a horizontal bar *E* upon the end of which is a head *F*, shown in Fig. 2, carrying three rollers, one roller on the top immediately below the two copper electrodes *G* and the other two at an angle of about 120 degrees. These two lower rollers hold the boiler shell against the pressure rolls *A*, while it passes through the machine. Behind the machine (see Fig. 2) is a device similar in construction to the regulation draw bench, and having an endless chain *H* carried on pulleys at either end of a planed guide between which the chain runs.

The chain is attached to a carriage *I* provided with a gripping device which grips and draws the boiler shell between the pressure rolls during the welding operation. In front of the machine and secured to the base is a yoke *J* (see Figs. 1 and 3) through which the boiler shell passes on its way to the pressure rolls and welding electrodes. The object of this yoke is to guide the shells and keep the joint exactly equidistant from each electrode during the welding operation as the success of the weld depends to a great extent on the seam being guided in a straight line and half way between the electrodes. The yoke is provided at the top on the side next the machine with a thin blade of steel (not visible in the half-tone) which locates the boiler shell by the edges which pass one on either side of it. The yoke and other controls for the boiler shells are all within easy access of the operator.

Owing to the extreme flexibility of these thin boiler shells the adjustments and movements of the electric welding machines must of necessity be very exact and under instant and absolute control; a boiler shell 6 feet long taking but 22 seconds to weld from end to end does not permit of cut-and-try methods of adjustment.

Mounted on the base is the main frame *K* of the machine which carries at the top the transformer *L* which is of the Thomson type. The primary circuit varies as previously stated, from 250 to 350 volts, depending on the character of the work; the transformer steps it down to from 2.5 to 4.5 volts, this also being governed by the character of the work.

The current is led from the transformer to the rotary electrodes *G* secured by bolts to gun-metal spindles approximately 4 inches in diameter which run in gun-metal boxes in the heavy gun-metal saddles *M*. The saddles *M* are insulated from the cast-iron frame *K* of the machine by sheet mica approximately 3/16 inch thick.

The spindles which carry the electrodes are hollow to permit a circulation of cooling water which passes through the transformer and both spindles of each machine. The piping and valves show plainly in all the views. The cooling is necessitated by the heavy amperage, in the neighborhood of 24,000 amperes being required for electric welding.

The current passes from the saddles to the spindles or *vice versa* at the points of contact, and among these points of contact are the two bearings. When the bearings become worn slight sparking is liable to occur which has the tendency to make the bearings cut. But in spite of this sparking and the fact that gunmetal and gunmetal do not run well together these bearings run from 12 to 14 months without renewing. When it does became necessary to renew the bearings the spindle is so made that a new sleeve of gunmetal can be driven on the spindle proper after the worn one is removed and the half bearings in the saddle and cap are readily replaced.

The electrodes *G* are copper disks secured to a flange on the spindle ends by tap bolts from the back. They are 1¼ inches thick, and about 26 inches in diameter. The spindles are inclined at such an angle that the electrodes where they are nearest to each other are about ¼ inch apart. This is at the point in contact with the boiler shell, and at this point

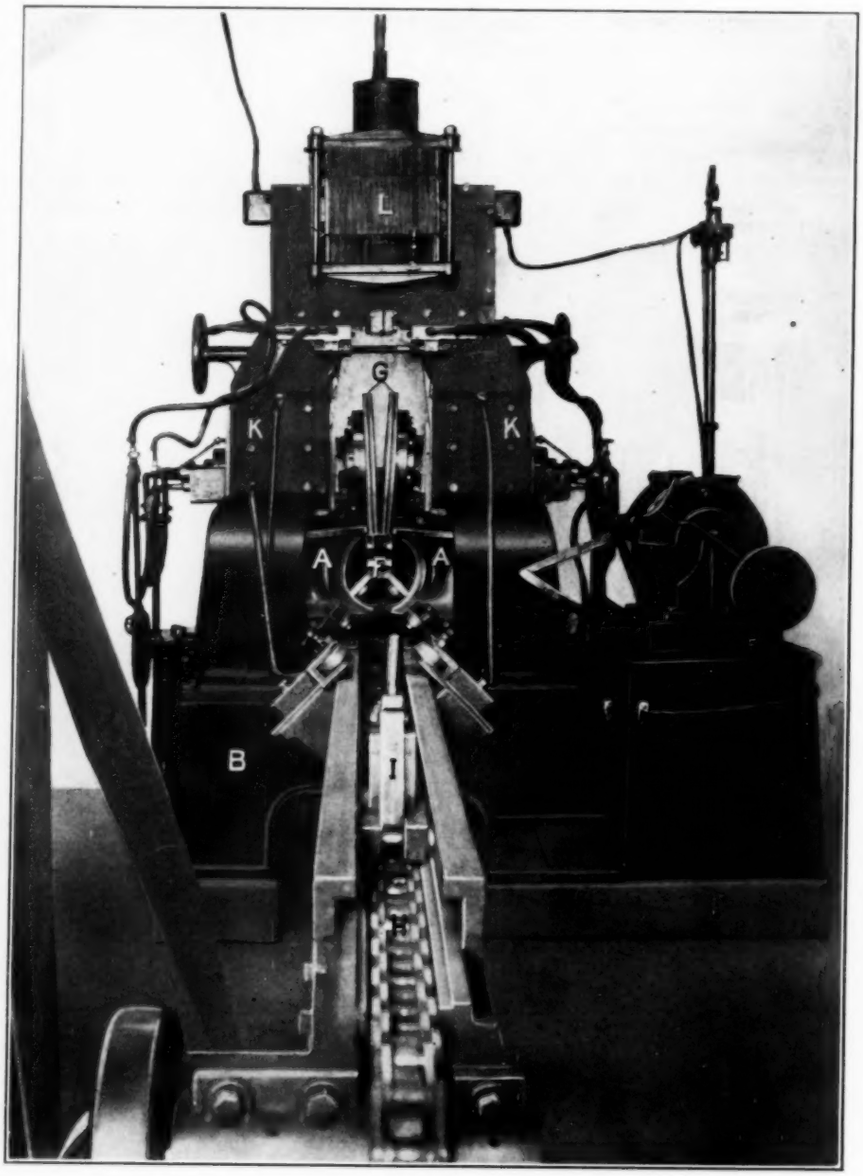


FIG. 2. REAR VIEW OF ELECTRIC WELDING MACHINE

the welding is performed. On the opposite side the disks are about 2½ inches apart.

The operation of the machine is as follows: The rolled boiler shells are lifted into the front of the machine with the seam up, as shown in Fig. 3, passed through the yoke, the small blade mounted on the yoke passing between the edges at the seam and locating the shell so that it will pass through with the seam equidistant between the two electrodes. The shell is then gripped by the clamp on the carriage *I* (see Fig. 2) at the back of the

From putting one 5-foot shell in until the putting in of the next the elapsed time is about one minute, the actual welding taking but 22 seconds. The shell is red hot for a space only about ⅛ inch in width and the blue color caused by the heat extends for less than an inch on each side of the weld. During the welding operation one can put one's finger on the shell 2 inches back from the red-hot weld and not feel that it is warmer than the surrounding atmosphere.

Owing to the shape and pressure applied to the shell by the electrodes and the inside curvature of the boiler shells *C* and being of a length greater than the longest boiler shell.

On either side of and above the stake are a pair of guides *D*, and at the front and back of the machine are a pair of idlers over which travel two parallel endless chains which are driven by a 7½ horsepower motor. These carry a rounding-up roll *E* conforming to the outside curvature of the boiler. The operation is as follows: The boiler shell is placed on the die on the stake with the welded seam up. The clutch is then thrown in and

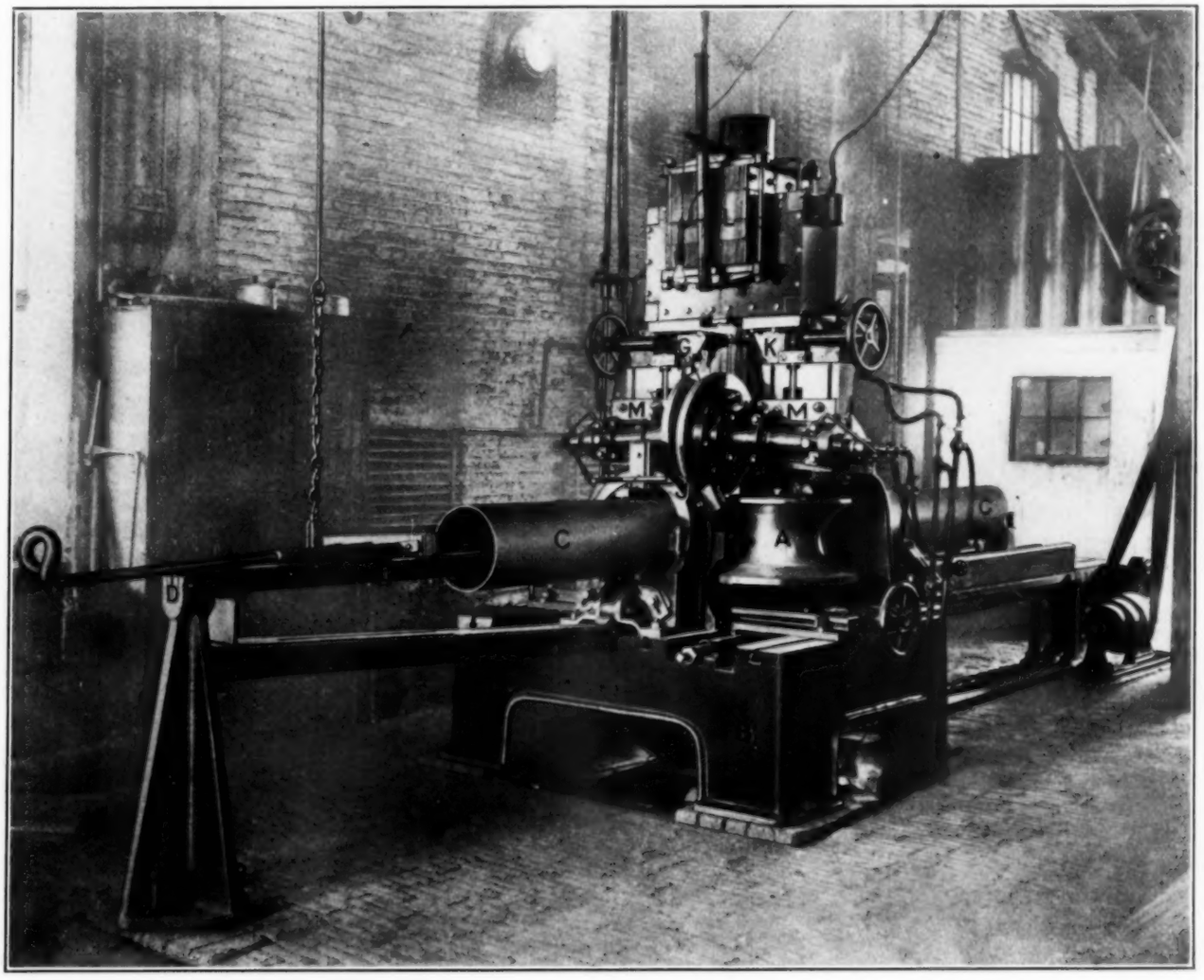


FIG. 3. ELECTRIC WELDING MACHINE, SHOWING A SHELL IN STARTING POSITION AND ONE AT FINISHED POSITION

machine and the draw bench started. This draws the shell backward between the pressure rolls and under the electrodes. The moment the seam strikes the electrodes the current is switched on and the weld starts. As no instruments are used to determine the heat at point and time of weld I cannot give any exact figures but a reasonable guess would place the temperature at about 2800 degrees Fahrenheit. The two edges are pressed together by the pressure rolls and the semi-fluid metal forms on the outside of the seam in the shape of a half-round bead running the full length of the welded shell.

roller on the inside of the shell the finished product as it comes from the welder is out of round, being approximately as shown in Fig. 5, *A* being the weld, *A B* and *A C* are flat. The shells after leaving the welding machine, and previous to putting in the upper head are rounded up to make them nearly true cylinders. This job is done very rapidly on a special machine built in the works.

This rounding-up machine (shown partly in section in Fig. 6) has a horizontal stake *A* with a planed surface on top to which various sized dies *B* can be readily fitted, the dies conforming to the

the rounding-up roller *E* is drawn by the chains on either side along the seam, guides *D* on top forcing it against the outside of the distorted boiler shell. One pass is sufficient to bring the shells to perfect cylindrical shape.

After passing the rounding-up machine the shells are tested under pressure to detect faulty welds. For this test a tank some 8 feet long by 3 feet wide and 4 feet deep is used. The shells are laid with the weld uppermost on a horizontal rest in the tank which is filled nearly full with water. The rest descends into the water, and as both ends of the shell are open it fills in-

stantaneously. Two packed heads then come forward and grip the shell tightly between them. The heads with the shell between them then rise out of the water bringing the welded seam in a position where it can be readily inspected by the operator. One of the heads is equipped with a water connection to a hydraulic accumulator which permits a pressure of 250 to 300 pounds to be applied almost instantly. After passing this test the side opening in the boiler is punched and a malleable iron "spud" or bushing is riveted in. The shells then go to the heading furnace, one end of the shell is heated and the upper head is inserted. These heads are a little larger than the cold shell, so that when in place and the shell cools they are shrunk in.

The shell with the upper head in place then goes to the punching machine, which has a very long stake and the holes are punched through shell and head for the rivets. These are put in by a machine similar to the punching machine and are put in hot because of the long reach and flexibility of the stake, it being impossible to support the stake near the end where the pressure is applied to the rivet. These heads are riveted in at the rate of about 35 per hour per machine. The shell is then heated and the bottom head inserted in the same way that the top one was. The punching in this end is done on a more rigid machine because there is practically no overhang and the riveting is done with cold rivets for the same reason, the speed being about 50 per hour.

After the heads are riveted in, the shell is calked down close to the head with an ordinary pneumatic hammer. The boiler then passes a visual inspection and then goes to the pickling vats where it is first treated with a 5-per cent. sulphuric-acid solution at 150 degrees Fahrenheit for about an hour. From the sulphuric-acid bath the boilers are washed in commercial muriatic acid to stop the action of the sulphuric acid. This pickling is preparatory to galvanizing. The shells next pass to a special drying oven, shown at *A*, Fig. 7. This oven is approximately 3 feet high, 7 feet wide and 12 feet long, and is open at both ends. The floor is composed of T-irons spaced about a foot apart with the T inverted and the bars running the length of the oven. The floor inclines toward the galvanizing tanks so that the boilers roll by gravity toward the tank, being wet when placed in the far end they dry and approach the galvanizing tank gradually as tank after tank is removed from the front end of the furnace and placed in the molten zinc. The drying oven is heated by coke and the hot gases pass under false bottoms and return to the firing end before escaping.

The spelter tanks *B* are 9 feet long, 36 inches wide and 42 inches deep. They are built of 1¼-inch steel plates riveted together. They are fired with 48-hour or gas-house coke. The bottom rests on a solid firebrick foundation. The fire chamber is 6 inches wide and extends the full length and hight of the kettle. Ordinary commercial Western spelter is used, each pot requiring approximately 18 tons of zinc to fill it. The temperature of the zinc is kept about 850 degrees Fahrenheit, and it takes about 24 hours to attain this heat starting with a cold pot.

The top of the zinc is covered with powdered salammoniac, which acts as a cleaner and a flux. The boilers are taken from the drying oven by the operator and placed in the zinc pot where they are rolled over and over, the molten zinc entering the holes in the ends and side until the boiler is about half full. During the galvanizing operation the operator keeps a sharp lookout for defects where the zinc refuses to adhere. Should such spots be found they are treated with fresh salammoniac. The usual time of immersion in the zinc is from one to three minutes; this galvanizes the boilers both inside and out. In taking the boilers from the pots they are raised in a vertical position, the excess of zinc draining out of the holes in the head back into the pot again. The shells are then laid on their sides on the trestles *C* and rolled back and forth while the zinc sets so as to prevent the liquid metal from settling in a lump at any one point.

A 30-gallon boiler, that is, a boiler nominally 12 inches in diameter by 5 feet

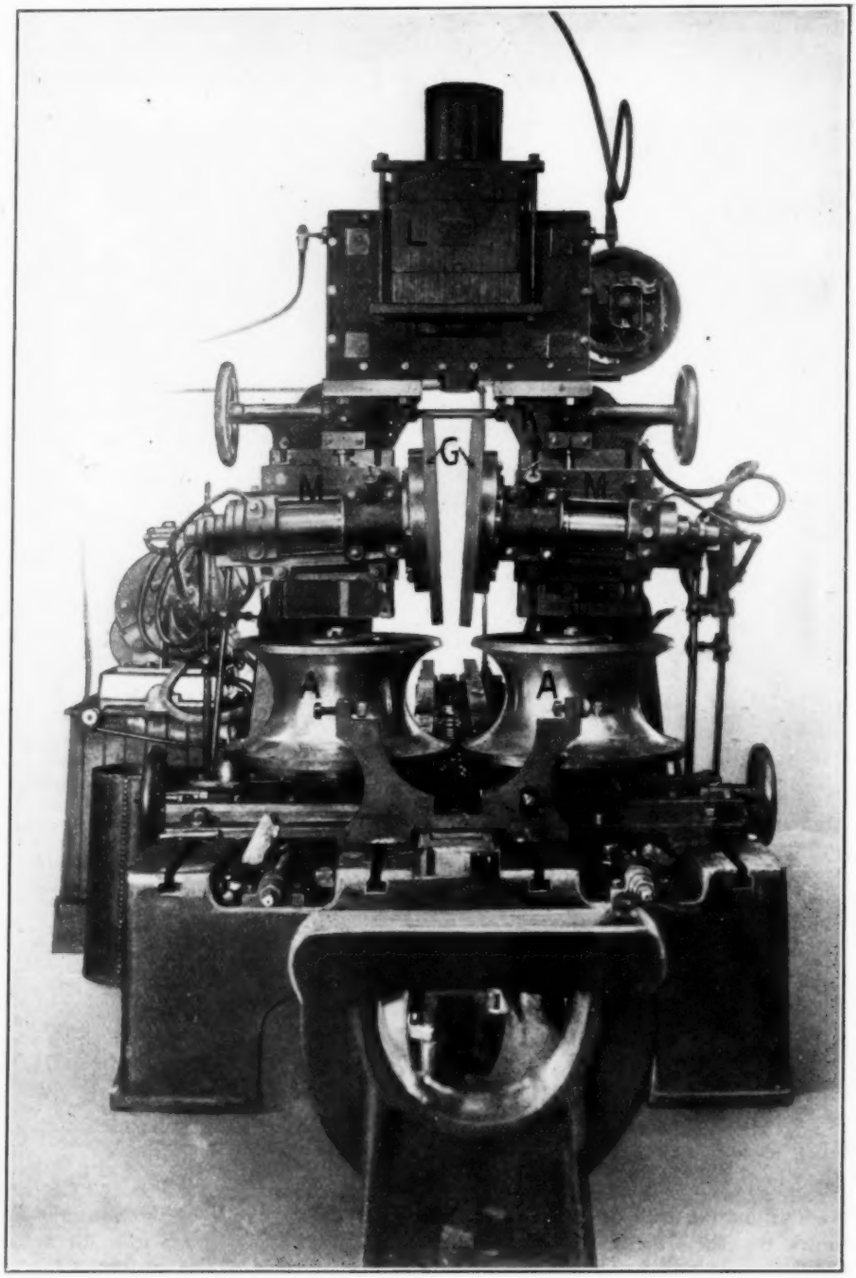
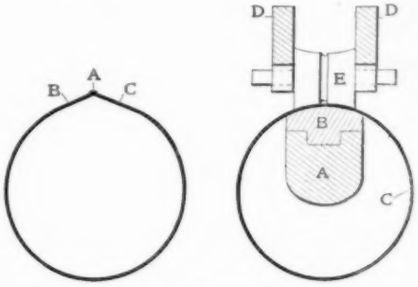


FIG. 4. FRONT OF ELECTRIC WELDING MACHINE WITH YOKE REMOVED

long is made from a sheet 36x58 inches, and takes about four pounds of zinc in the galvanizing bath. In galvanizing from 25 to 30 per cent. of the spelter goes to dross. This sells to the refiners for about 75 per cent. of the cost of new spelter. There is also a loss of about 10 per cent. in skimmings, which sells for a cent and a half to a cent and three quarters a pound.

The original works are situated on the left bank of the Schuylkill Navigation Company's canal. When the ab-



FIGS. 5 AND 6. SECTION OF SHELL AND ROUNDING-UP MACHINE

normal growth of the concern compelled the acquisition of more land, the only available ground was a strip on the other side of the canal lying between it and the Schuylkill river. The objection to this property lay in the transporting of the goods across the canal.

This was overcome by placing a covered bridge over the canal with a large hydraulic elevator at either end. One of these elevators is in a corner of the galvanizing room. The trucks loaded with galvanized boilers are pulled onto the elevator, raised, drawn across the bridge to the other elevator situated in the shipping room and lowered to the floor level. In the building occupied by the shipping room are the machine shop, where all the special machines are built and where the general repairs for the entire factory are attended to, and the tapping department where the pipe connections in the boilers are tapped and where the final hydraulic test is put on the boilers. From the elevator the boilers go to the tapping machines, of which there are four, three of which are shown in Fig. 8. The machines are now driven by individual motors but were originally designed to run from the main shaft, and to dispense with countershafts a very ingenious clutch was designed. The line cut, Fig. 9, shows the tapping machine, Fig. 10 shows the tapping carriage and Fig. 11 shows the details of the clutch mechanism. Referring to Fig. 10, which shows side and end views of the tapping carriage, the tracks *A B* are secured to the floor in front of and at right angles to the spindle of the tapping machine. On them run the wheels *C* of the carriage *D*, which is itself composed of two tracks secured together by tie-rods. On these two tracks the wheels *E* run. They are secured to the lower part of the indexing tables *F* and upon the upper part of the table *F* are mounted three large V-blocks *G*, in which the boilers are laid and secured by a strap of steel (shown in Fig. 8) having a quick-acting toggle clamp. Between the upper and the lower tables there is a race with ½-inch balls, so as to facilitate turning on the center stud *S*. A chain *H* reaches from end to end under the lower table and engages with a sprocket mounted on

FIG. 7. THE GALVANIZING ROOM

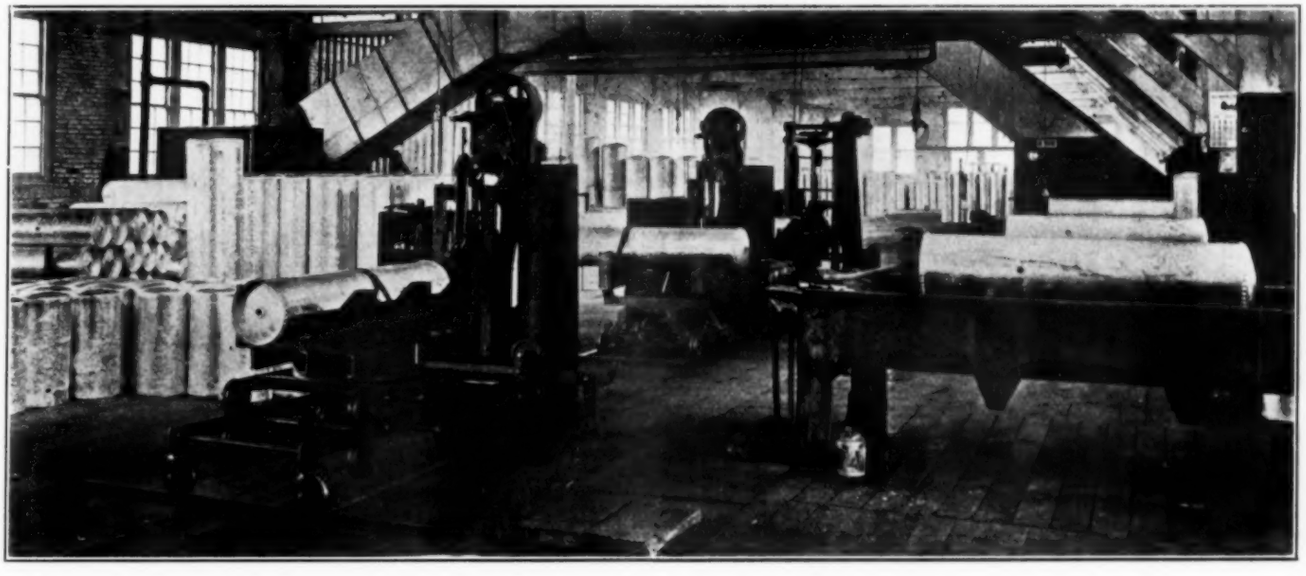


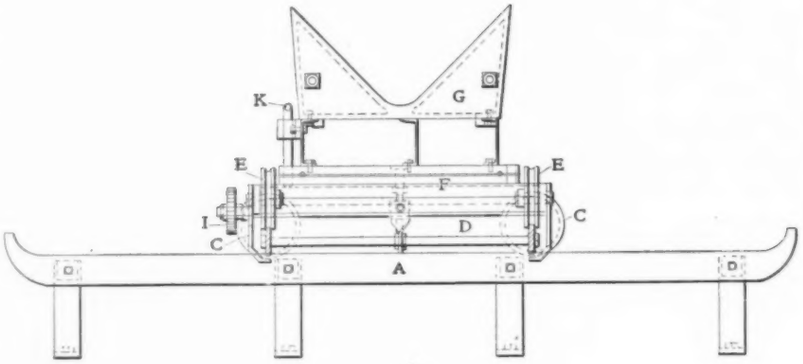
FIG. 8. TAPPING AND FINAL TESTING DEPARTMENT

a shaft in the lower table. This shaft at the operating end has a ratchet *I* and lever *J*, so that the table and affixed boiler can be forced against the tap. The upper table is provided with an indexing pin and the lower table with four indexing holes spaced 90 degrees apart.

In tapping these boilers which have one hole on the side, two on the top and one on the bottom, it has been found that a reversing machine wastes considerable time, therefore the operation is as follows:

A boiler is mounted in place, a tap is run in one hole in the top; when it reaches the proper depth the tapping machine is tripped and a second tap is put in the second hole; when this reaches correct depth the tapping machine is tripped, the carriage is indexed 90 degrees and a tap is run into the side hole. While this tap is running into the hole, the operator, with a cranked tap wrench, removes the two taps from the end. The letter *X* in the line-cut shows the position of the tap.

Fig. 9 shows the tapping machine. The head *C*, which carries the tap-driving and trip mechanism *E*, is accurately balanced so as to be readily raised or lowered by the operator to suit the various diameters of boilers on the tapping stand. This accurate balance is obtained in a very simple manner, the counterweight *D* being cast hollow, the correct weight to balance *C* is obtained by filling it with the required number of punchings.



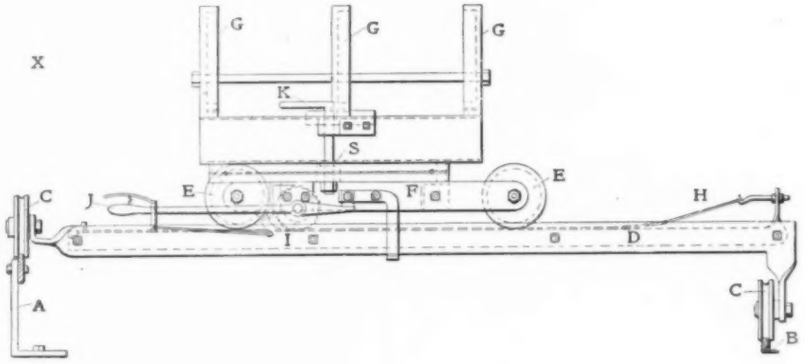
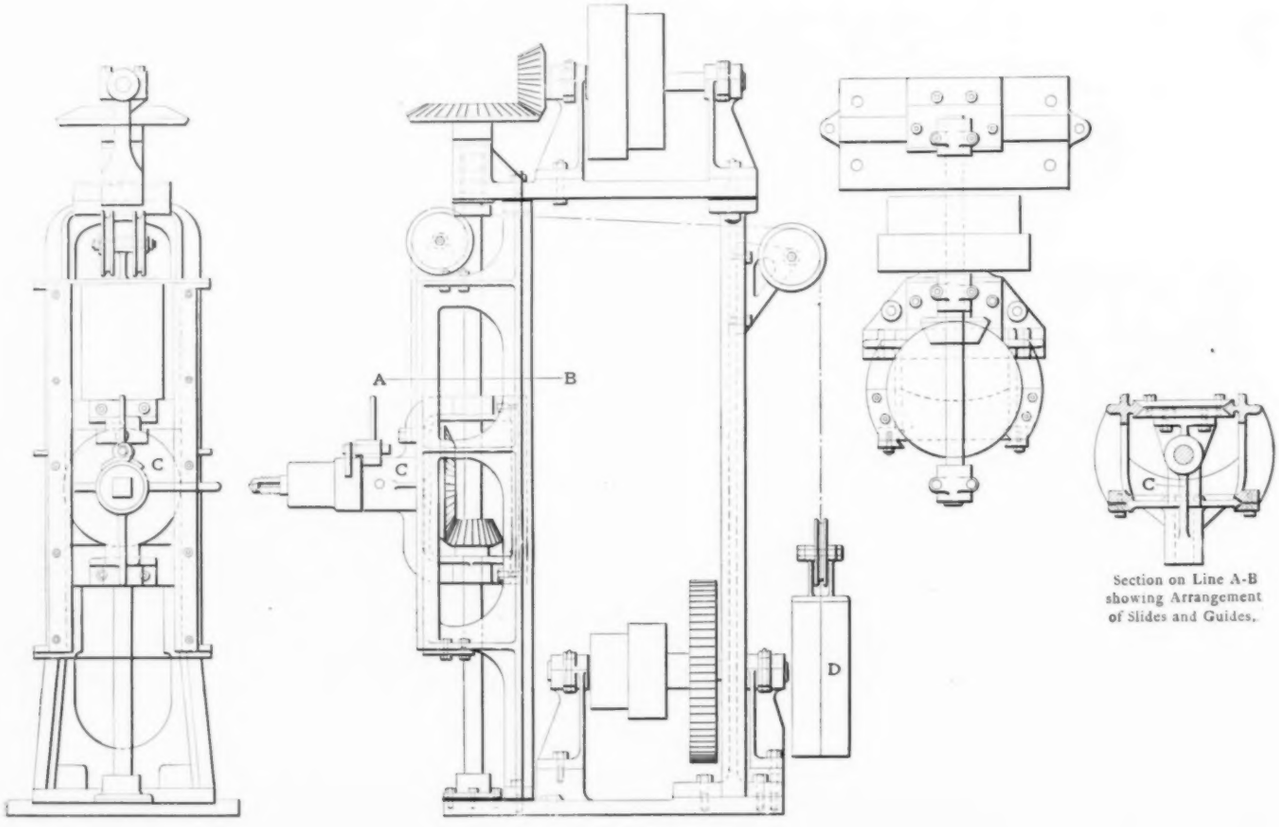


FIG. 10. THE TAPPING CARRIAGE



Section on Line A-B showing Arrangement of Slides and Guides.

FIG. 9. THE TAPPING MACHINE

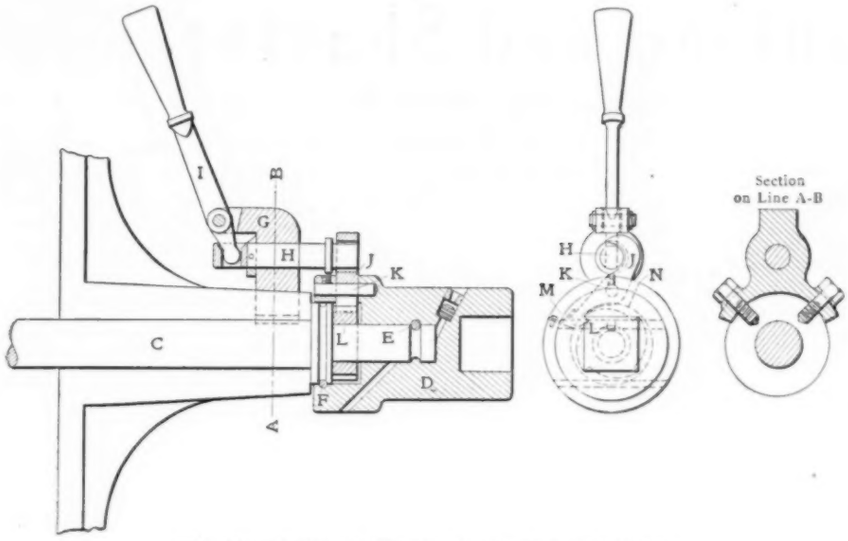


FIG. 11. DETAIL OF CLUTCH ON TAPPING MACHINE

The trip mechanism is shown in detail in Fig. 11. The spindle *C* is running continuously. On the end of it is the loosely mounted tap holder *D*, which is prevented from dropping off by the two pins *E F*, which run in the two half-round grooves shown.

Mounted in the lug *G* is the pin *H*, which is actuated in or out by the lever. Mounted in the tap driver *D* is the pawl *J*, pivoted on *K* and capable of engagement with the ratchet formed on the spindle. A small flat spring *M* keeps the pawl *J* in engagement with *L*, and when it is thus engaged the spindle drives the tap holder, but with the pin *H* in the position shown, the pawl *J* is tilted back until it strikes the end of the recess *N*. This lifts the pawl out of engagement with the ratchet *L* on the spindle and stops the tap driver *D*. To start the driver the pin *H* is drawn back and the spring *M* throws the pawl into engagement with the spindle ratchet. From the tapping machines the boilers go to the testing tanks, shown in Fig. 8 to the right, which are so placed that the tanks can be lifted direct from the tapping carriage into them. Here they are tested to 175 pounds for the standard and 200 pounds for the extra heavy. After passing inspection and test the boilers either go to stock or back to the boiler shop to have any defect corrected. Defects in the seams are corrected by gas welding.

So far only the electric welded shells have been referred to, but as I wish to compare them with riveted and oxy-acetylene welded shells, I will state briefly the methods by which these two varieties of shell are produced. The sheets for the riveted shells are punched in the flat at both ends, but two strokes of a multiple punch being necessary. The rivets used are ⅜ inch in diameter and ¾-inch pitch. The sheets are then rolled to cylindrical shape, riveted and then the seam is brazed. This takes about five minutes' time and 1½ pounds of brass at 13½ cents a pound.

The subsequent operations on these boilers are practically the same as those on the electric welded ones. The oxy-acetylene flame has been described so many times that a repetition is not necessary here. The John Wood Manufacturing Company has a complete installation with two complete generating plants for oxygen and one for acetylene. They use it for welding heads to shells where this is ordered but it requires too much space to apply to long seams.

Many tensile and vibratory tests have been made of electric welds made by this concern in various ways, plain butt welds, heavy butt welds in which the plates were forced together so that a large amount of molten steel was raised on either side, and lap welds.

The percentage of defective welds made with the electric welding machine is about 0.1 per cent. In not one single case has an electric weld pulled apart at the weld. No piece tested has shown any crystallization either at the weld or at any place within the influence of the heat. All test pieces pulled apart at a point beyond the influence of the heat.

The oxy-acetylene-welded test pieces show a crystalline fracture, and, while the sectional area in the gas weld is increased 50 per cent., one of the test pieces failed partly in the weld. The tensile strength of the gas weld is good, but it does not stand up well under the vibratory test. The riveted and riveted and brazed seams invariably pull apart at the rivets.

Test No.	Section, Orig.		Area, Orig.	Elastic Limit, Per Sq.In.	Ultimate, Per Sq.In.	Elongation Per Cent. In.		
						8"	2"	
1	2.66	0.084	0.223	43,230	45,520	2.5	7.0	Plain riveted.
3	2.82	0.100	0.282	37,450	56,210	13.8	15.0	Riveted and brazed.
5	2.30	0.085	0.195	45,800	59,640	17.0	26.0	Gas welded.
7	1.923	0.081	0.156	42,570	50,130	2.0	5.0	Electrically welded.
10	1.922	0.080	0.154	47,670	64,420	20.5	36.0	Electrically welded.

FIG. 13. TESTS OF RIVETED, RIVETED AND BRAZED, GAS WELDED AND ELECTRIC WELDED SEAMS.

Comparing the costs of the three methods of making the longitudinal seams, taking the electric weld as 1 the gas weld would be about 7.5 and the riveted and riveted and brazed seams about 10. Fig. 12 shows a typical test bar, the fracture occurring beyond the influence of the heat.

Fig. 13 shows a series of tests giving about average results. The plain riveted and riveted and brazed seams both failed at the rivet holes. The gas weld failed partly at the weld and then the fracture ran at an angle. The electric welds failed beyond the part heated by the electrodes.

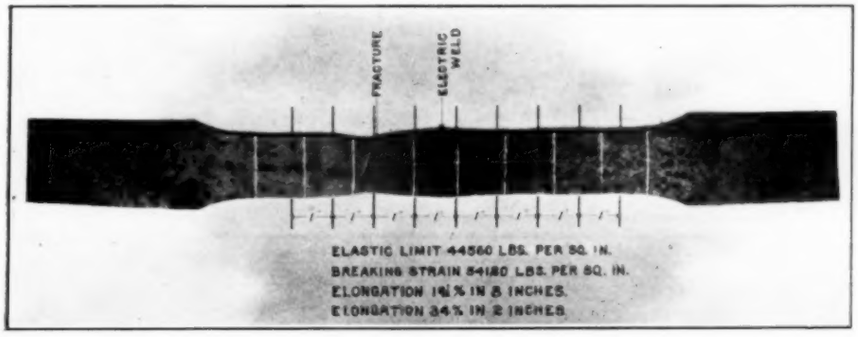

FRACTURE
ELECTRIC WELD
ELASTIC LIMIT 44560 LBS. PER SQ. IN.
BREAKING STRAIN 54180 LBS. PER SQ. IN.
ELONGATION 14¼% IN 8 INCHES.
ELONGATION 34% IN 2 INCHES.

FIG. 12. TYPICAL ELECTRIC-WELDED TEST BAR

From reports recently published by the Bureau of Statistics, diamonds show a marked falling off in the imports of 1908, those uncut being valued at less than $4,500,000 in 1908 against more than $11,000,000 in 1907, and diamonds cut but not set, $9,000,000 against $24,000,000 in the immediate preceding year.

Sectional Blanking and Shaving Dies

The Sheet Steel Parts Used in the Burroughs Adding Machine Are Blanked Out and Finished by Press Tools of Unusual Construction

EDITORIAL CORRESPONDENCE

In the mechanism of the Burroughs adding machine there are a number of sheet-metal members which have to be finished very accurately at certain points and for such parts after they are blanked, shaving dies are used which insure the bringing of every important portion of the piece to the exact form and dimension required. These dies are built to shave only such edges of the work as cannot be finished with sufficient accuracy in the blanking die; that is, instead of shaving in all cases the entire contour of the blank, they may finish, say, the edge of an important projection, the end of a lever which must take a bearing at that point, or shave out a notch or opening which acts in conjunction with some stud or roller to produce an accurately timed movement. In the case of certain gear wheels incorporated in the mechanism the entire periphery of the work is finished by shaving tools; sometimes two or more sets of shaving dies and as many operations being employed to assure the best possible results. Also, certain piercing operations where the correct locations of the holes is of prime importance, are performed after the work is blanked out and in conjunction with the shaving operations.

Some of these press tools as constructed and used at the shops of the Burroughs Adding Machine Company, Detroit, Michigan, are illustrated in the accompanying engravings.

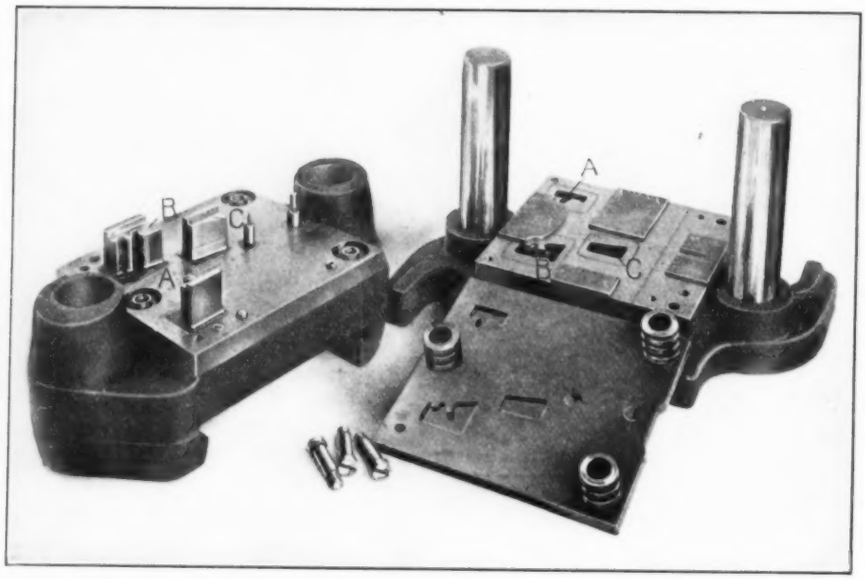


FIG. 1. SHAVING PUNCH AND DIE

Shaving Tools for an Irregular Arm

In Fig. 1 a typical set of tools is represented, the upper and lower members being alined, sub-press fashion, with posts at either side. The blank to be shaved and pierced is shown in Fig. 2, on which drawing for the sake of clearness, only a few of the leading dimensions have been retained. The piece has to be shaved along the irregular ends *A* and *B* and on the sloping projection *C*. The hole at the end and the smaller hole at the right are pierced with the same tools. The punch and die are built up in the manner illustrated in Fig. 1. The die block of machine steel is milled out to receive the three rectangular dies *A*, *B* and *C* for finishing the edges marked with corresponding reference letters in Fig. 1. It also is fitted with the two piercing dies whose punches are plainly shown inserted in the punch-holder plate at the left of the die. The shaving punches are identified in the half-tone by the same letters (*A*, *B*, *C*) as are used for the inserted dies. These punches are inserted solidly in the main block and to prevent any possibility of their springing outward while operating upon the blank, their backs are extended somewhat beyond the cutting faces and thus enter well into the dies before commencing to shear the material. The extensions thus formed by the noncutting faces of the punches fit nicely against the noncutting faces of the dies, and in this way the punches are so well supported that there is no opportunity for them to spring away from the work. The cut taken is a light one; the blank is well located by the nest formed by a series of plates

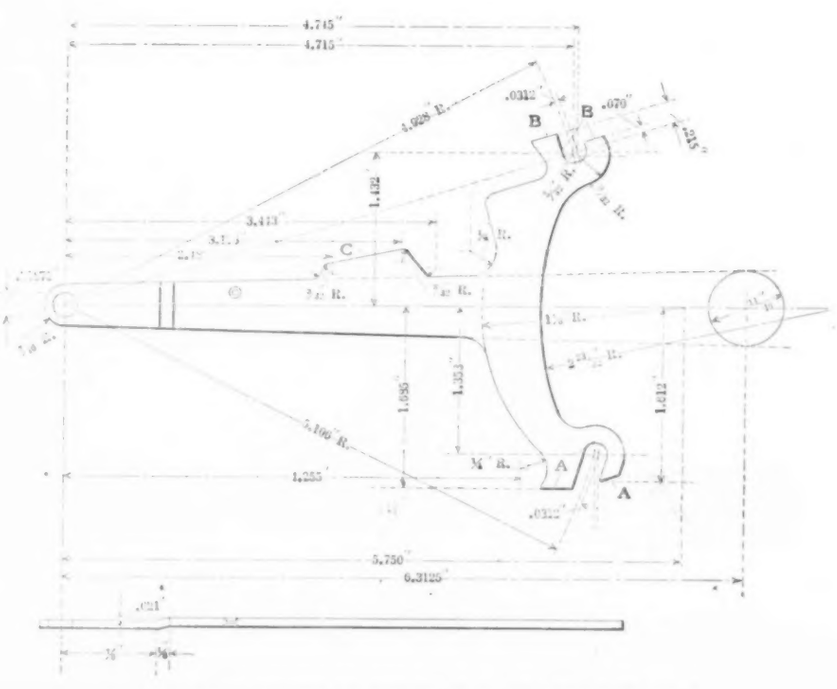


FIG. 2. WORK SHAVED BY THE PRESS TOOLS SHOWN IN FIG. 1

attached to the face of the die, and after the shaving operation the piece is exactly what is called for by the drawing.

The right-hand portion of the die-block face will be seen to be slightly lower than the remainder of the surface. This depression accommodates a slight offset at the narrow end of the piece, Fig. 2, which offset is made in an operation preceding the shaving of the edges at *A*, *B* and *C*.

The method of locating the stripper springs by means of annular channels will be noticed upon examining the faces of the punch block and the stripper plate shown at the front of the die. Both punch and die members it will be observed are so constructed as to be easily placed in the press.

Using Two or More Sets of Tools

A large number of press tools of the type just described are used at the Burroughs factory, these differing in detail to adapt them to the particular piece of work they are to handle. Where a blank requires to be passed through two sets of shaving dies it is customary to reverse the piece at each operation; thus it is blanked from one side, turned over and shaved the other side up and then turned again for the second shaving operation. Every precaution is taken to insure the best possible results in the finished piece and this is well illustrated by the practice of reversing the work as described, shaving the edge first from one side and then from the other, to obtain a clean, square surface.

Where a cut to be made in a shaving die is of such a nature as to be likely to deflect the blank operated upon, as in shearing out a notch or shaving off a projection at one side of a slender arm, springing away of the work is sometimes guarded against by blanking out the piece originally with an extra projection on the side

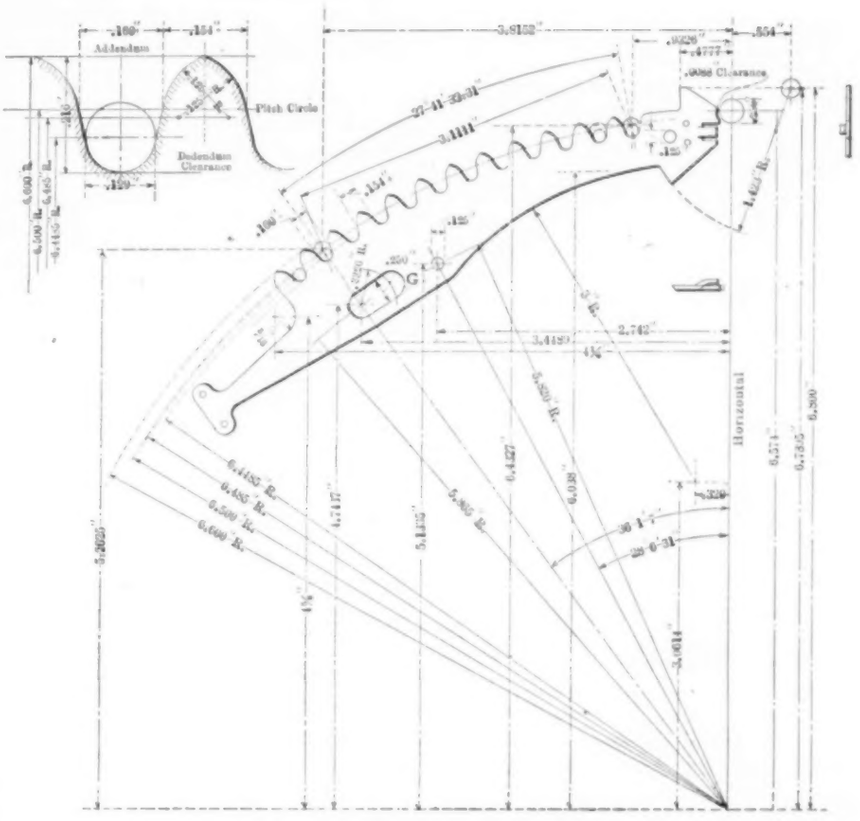


FIG. 6. TOOTHED SEGMENT OF SHEET METAL

directly opposite the point to be sheared off; the shaving tools then being made with an extra punch and die section to remove the superfluous metal at the same time that the important surface opposite is being operated upon. In this way the pressure sidewise against the blank is balanced and correct results assured.

Shaving Die for a Notched Member

A built-up shaving die is illustrated in Fig. 3 for finishing portions of the notches and rectangular openings in the fan-shaped end *D'* of the sheet-metal piece (known as the type sector) shown in Fig. 4. It also shaves that section of the edge indicated at *E'*, Fig. 4. The piece is blanked out and perforated, then shaved in a second operation die which is similar in construction to the one in Fig. 3, then the second or final shaving operation is performed in the die, Fig. 3, which, like the first shaving die, removes only a few thousandths at the point referred to. The

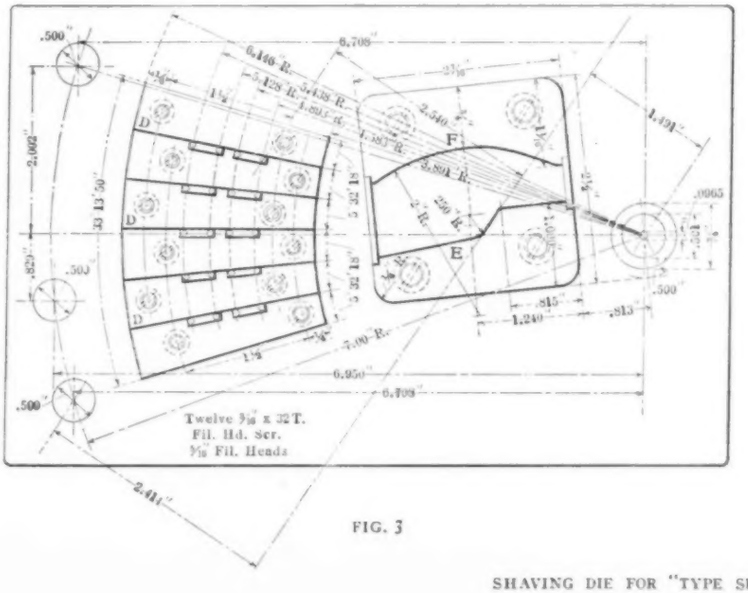


FIG. 3

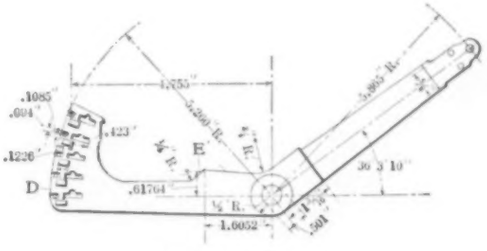


FIG. 4 The Work

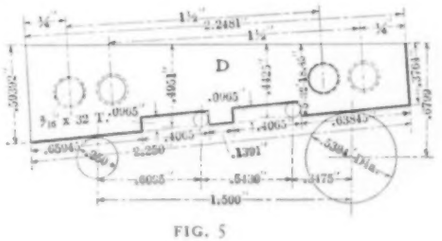


FIG. 5

SHAVING DIE FOR "TYPE SECTOR"

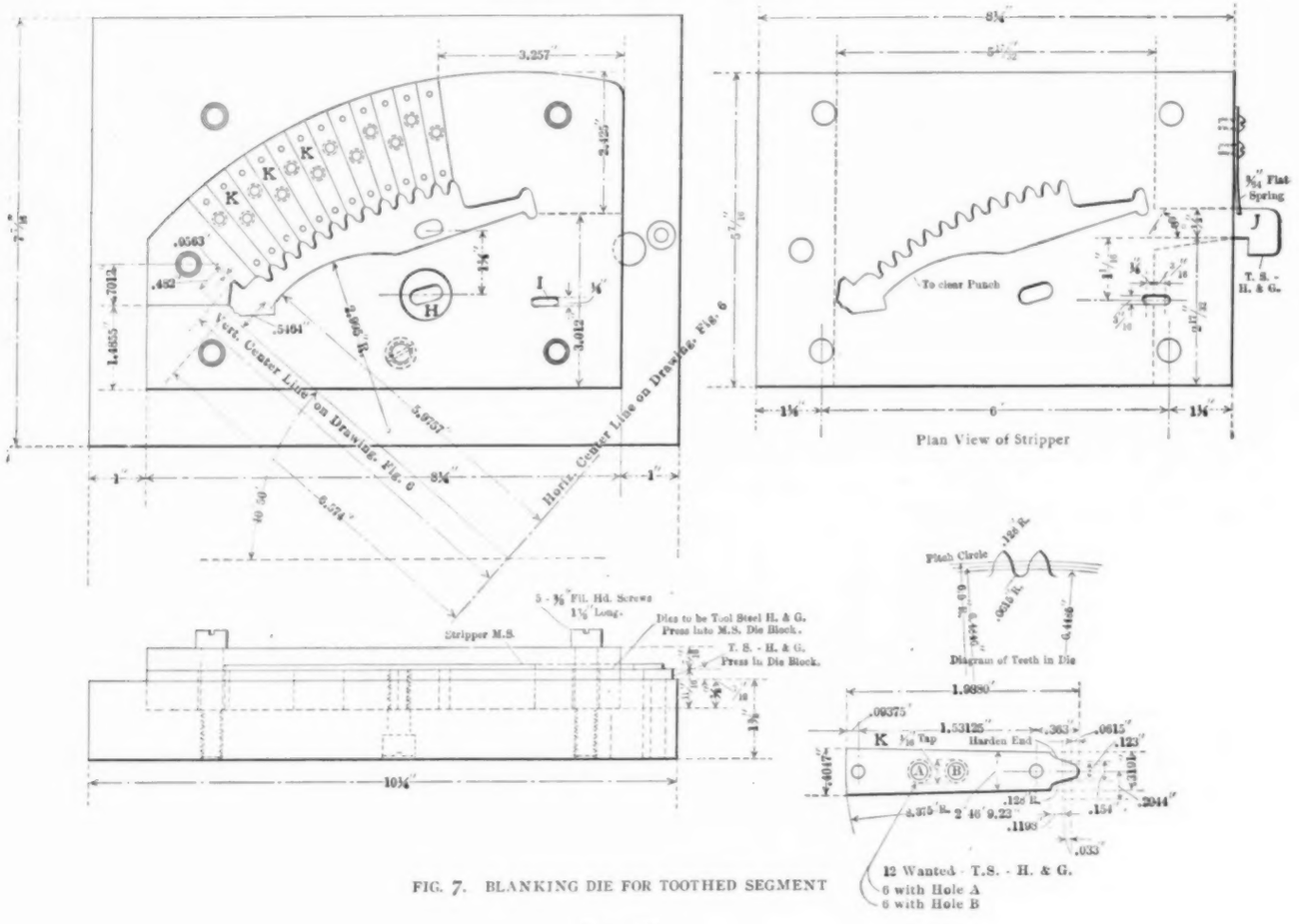

Plan View of Stripper
Vert. Center Line on Drawing, Fig. 6
Horiz. Center Line on Drawing, Fig. 6
To clear Punch
Stripper M.S.
Dies to be Tool Steel H. & G. Press into M.S. Die Block.
T. S. - H. & G. Press in Die Block.
Flash Circle
Diagram of Teeth in Die
12 Wanted - T.S. - H. & G.
6 with Hole A
6 with Hole B

FIG. 7. BLANKING DIE FOR TOOTHED SEGMENT

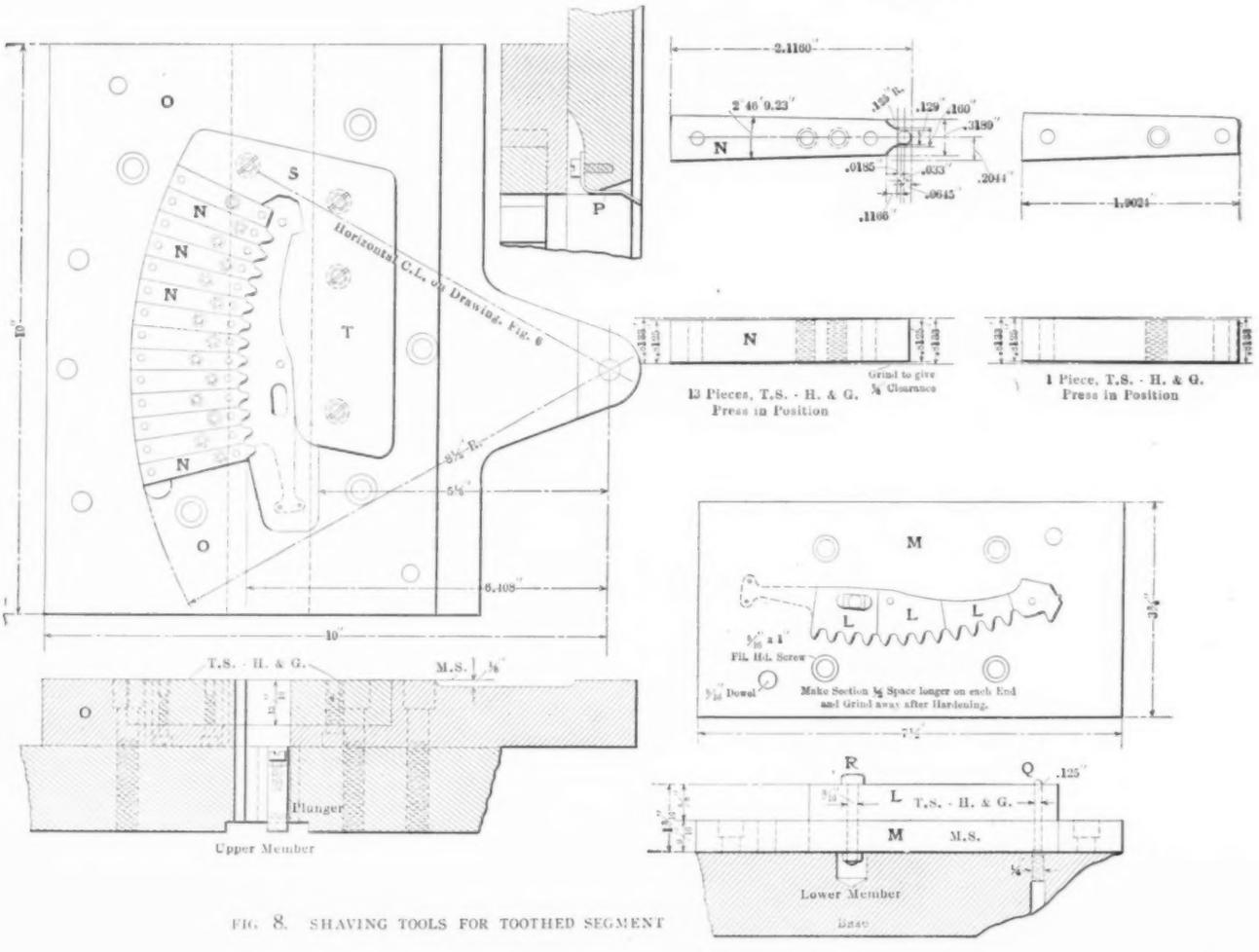

Horizontal C.L. on Drawing, Fig. 6
13 Pieces, T.S. - H. & G. Press in Position
1 Piece, T.S. - H. & G. Press in Position
Upper Member
Lower Member
Base
Plunger
Make Section ⅛ Space longer on each End and Grind away after Hardening.

FIG. 8. SHAVING TOOLS FOR TOOTHED SEGMENT

dies are made opposite hand so that the piece is shaved from one side in the first shaving die and finished from the other side in the die shown.

Like all of the Burroughs drawings, the blueprints showing the work and the dies have every conceivable dimension that can possibly be of service in the shop and tool room; however, to prevent confusion in the reduced scale engravings herewith many of the dimensions are left off as in the case of Fig. 2 already referred to. It will be seen that the die is composed of a half dozen tapering sections *D D D*, Fig. 3, and sections *E F* which are inserted in recesses formed in a machine-steel body and held by fillister-head screws. The tapered sections *D* are notched from one edge so that the other side of the shaving cut is taken on the straight edge of the adjoining section. A detail, to larger scale, of one of these wedge-shaped members is given in Fig. 5, and this also shows the method used in grinding the blocks to the correct size and degree of taper.

The piece is placed as represented, on two plugs with heads or disks of different diameters and located with their center line in a horizontal plane; these diameters and the center distance being determined by calculation so that with one of the edges of the work resting on the disks, when the piece is passed under the surface-grinder wheel it will be brought to the exact taper required.

The depth of the notches at the side of the die sections *D* is tested by means of round plugs laid in the opening as indicated in Fig. 5; and measurements can be made over these plugs to the opposite side of the block in reducing it to the necessary thickness. The dimensions at the ends and over the plugs in both notches are included in the detail.

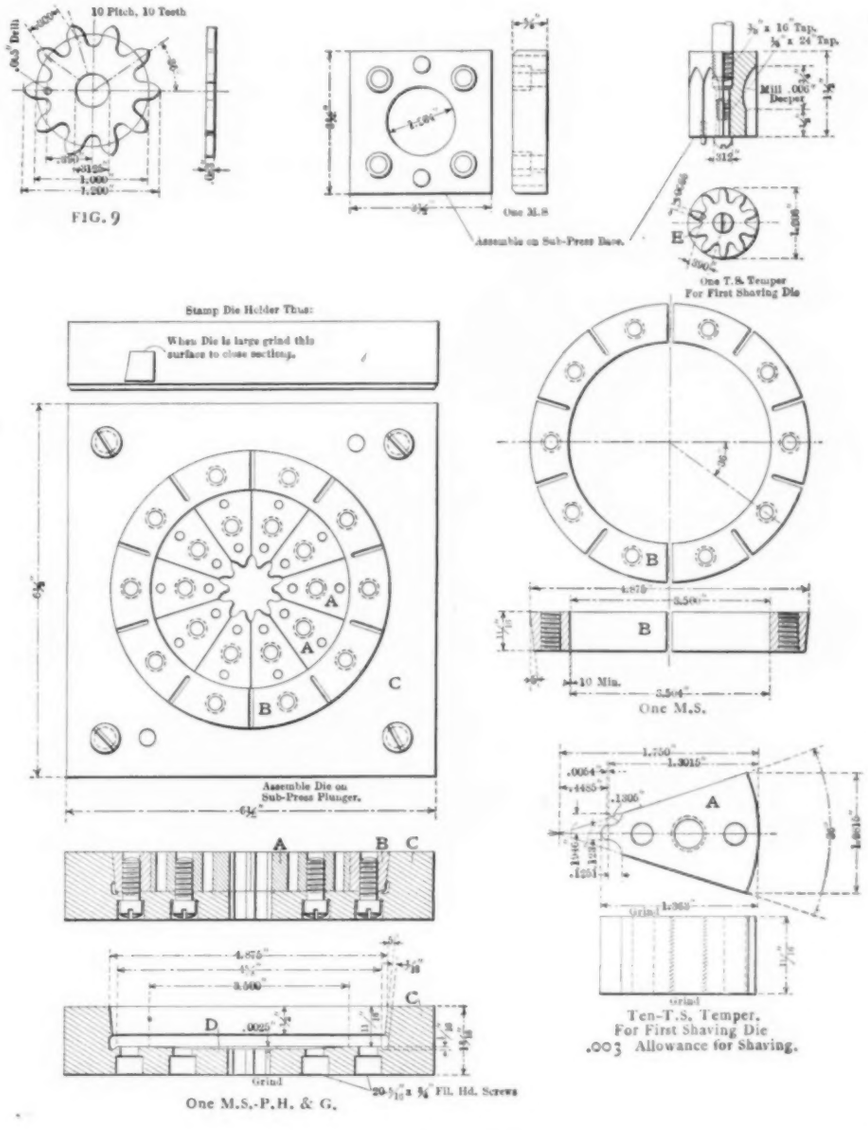

10 Pitch, 10 Teeth
Stamp Die Holder Thus:
When Die is large grind this surface to close sections.
Assemble Die on Sub-Press Plunger.
One M.S.-P.H. & G.
One M.S.
Ten-T.S. Temper, For First Shaving Die
.003 Allowance for Shaving.
One T.S. Temper For First Shaving Die
Assemble on Sub-Press Base.
Grind

FIG. 10. SHAVING DIES FOR GEAR BLANK

Pressed Tools for a Toothed Segment

The adding-machine part in Fig. 6 is a sheet-steel piece having along one edge a series of gear teeth, the exact form of which is shown more clearly in the detail sketch included in the same engraving. These teeth must be of correct contour, accurately spaced, and correctly located relatively to the other important sections of the piece. The segment is pierced at *G* and blanked in the die, Fig. 7, a slight amount of metal being left along the teeth and at other points for removal with the shaving tools, Fig. 8. At the stroke of the press which pierces the oblong opening *G*, Fig. 6 (the die for which is inserted at *H*, Fig. 7), a notch is cut in the edge of the sheet stock over die opening *I*, Fig. 7, which notch locates the material in the correct position against gage *J* when fed forward for the blank to be cut out at the next stroke of the press.

The die is provided with 12 sections *K K* for blanking the teeth outlines, and three other sections for completing the outline of the blank. Similar construction is adopted in the case of the shaving die, shown in the drawing, Fig. 8, the latter engraving also illustrating the punch which is made in sections placed end to end as at *L L L* in block *M*. These punch sections, it may be stated, are made a little longer than necessary, and after hardening, are ground off on the ends until the exact width of tooth space is obtained at the joint. This construction prevents any appreciable error in the punch which might be caused by deformation in hardening were the punch made in one piece instead of in sections as represented.

The 14 taper-tooth sections *N N* incorporated in the die are ground, as shown in the detail with the bottom tapering slightly toward the front end so that when these sections are placed in their seat in the machine-steel die block *O* their shaving ends have ¼ degree clearance. The tooth curves are struck from two radii, and special devices are used in finishing these curves correctly on the ends of the die sections *N* and also for grinding the sides to the required taper. The corresponding members *K K* in the blanking die, Fig 7, are finished in much the same manner, although, of course, a higher degree of accuracy is called for in the production of the shaving tools, Fig. 8.

These tools, like the others shown, are all of the subpress type, the castings to which the punch and die blocks are attached being provided with pilots or guide posts (as in Fig. 1) for alining the two members correctly when in operation. As noted on the drawing, Fig. 8, the punch constitutes the lower member and the die the upper member of the pair. This prevents possibility of fine chips sticking to the die face as might be the case if the die were at the bottom. As the work passes up into the die it is prevented

from falling back by a spring, which is shown at *P* in the sectional view at the upper right-hand corner of the die plan.

The work is located on the punch *L* by pins *Q R*, which enter the oblong slot, and the small hole pierced in the blank in a previous operation.

It will be noticed that in addition to the row of tooth sections *N* in the die there are two other blocks *S T* for shaving the end and the back of the work; the opposite end of the work is not shaved and the die is left open, as shown, to clear that portion of the work indicated by dotted lines in the drawing.

Subpress Tools for a Small Gear

Fig. 9 illustrates a steel gear made with sectional press tools from stock 0.083 inch thick. This gear has to be produced very accurately, and after blanking, it is shaved in two different operations. One set of shaving tools is shown in Fig. 10. The die which is assembled in a block attached to the subpress plunger, consists of sections *A A* ground to an included angle of 36 degrees, and inclosed in a split ring *B*, which has a beveled exterior fitting the conical surface of the chamber in die block *C*. The bottom of the seat in this die block, as indicated at *D*, is dished slightly (0.0025 inch) and the ring *B* is slightly larger in the bore at the bottom than at the top, so that as the sections *A A* are drawn into place against their seat their inner ends drop slightly and so give the slight amount of clearance required at the cutting edges. The split ring *B* is fitted at the outset to draw snugly against the bottom of its seat in die block *C*, and after the die sections *A* have been ground on the face sufficiently to change the size of the gear at the pitch line, the very slight enlargement thus caused in the die is rectified by grinding off the bottom of the clamping ring *B*, thus enabling it to be drawn down farther and so set the die sections up the minute amount necessary to retain the true pitch diameter of the work.

The punch *E* which is carried by the subpress base has a small pin in its face which enters a hole drilled in the blank and so locates it correctly for the shaving operation.

F. A. S.

During the year 1908, 35 car-building companies in the United States and Canada built 78,271 cars, which is only 27 per cent. of the number built in 1907. These figures include subway and elevated cars, but not street railway and interurban cars. Of the cars built in the United States, 66,751 were freight cars for domestic service, 1206 freight for export, and 1566 passenger cars for domestic service and 71 passenger for export. Canada built 8593 freight cars for domestic service, 5 freight for export, and 79 passenger cars for domestic service.

Fixture for Milling Squares and Hexagons on the Ends of Shafts

By G. K. Atkinson

For milling hexagons and squares on elevating shafts, vise screws, bolt heads, etc., the John Steptoe Shaper Company, Cincinnati, Ohio, uses the fixture shown in the half-tone.

The spindle and index plate *A* is a gray-iron casting and has a tapered bearing in the base *B* which is gray iron also.

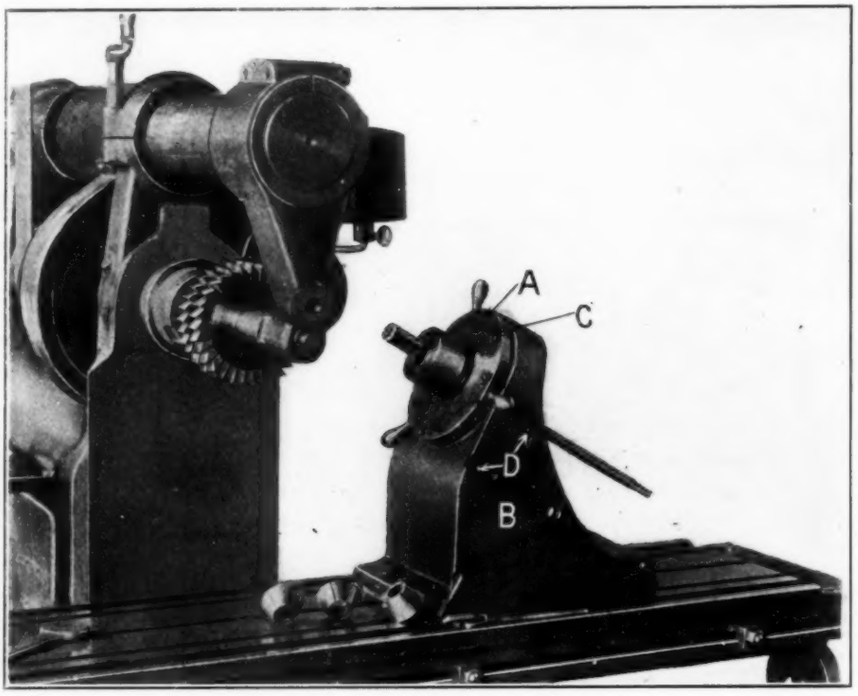
The chuck is the usual form, there being a collet for each size piece to be milled. The index plate has ten holes drilled through from the back and reamed for a 15-degree locking bolt. Four of the holes are 90 degrees and six 60 degrees apart. After reaming the holes for the locking bolt they were tapped the remainder of the way through to admit the round-head capscrew *C* of which there are twelve, six long enough to come flush with the back of the index plate and six short ones.

In milling a hexagon the short screws are put in six holes marked "6" to prevent chips getting in, and the long screws are put in four holes marked "4" to prevent the locking bolt getting in and spoiling the hexagon.

In milling squares the opposite course is pursued, thus making it almost impossible for a mistake to occur in indexing the work.

The spindle of the fixture is at an angle of 30 degrees to the table to facilitate chucking or removing long shafts or screws having a collar back of the square.

As will be noticed upon examination of the casting forming the body of the fixture, the sides are finished and two grooves are formed in the surface at *D* to receive locating tongues which permit the fixture to be turned over on its side and set with the spindle parallel with the milling-machine table for milling collar-head screws and work of a similar nature, with an end mill. It is obvious from the location of the grooves, seen at *D*, that the fixture when placed on its side, may be set either with its spindle extending longitudinally over, or crosswise of the milling-machine table. We have found the fixture to be a time saver as well as a mistake preventer.



FIXTURE FOR MILLING SQUARES AND HEXAGONS ON THE ENDS OF SHAFTS

While the slide rule has only become universally used for calculating purposes during comparatively recent years, it is interesting to note from comment on the subject made in the *Zeitschrift fur Vermessungswesen* that it was invented nearly 300 years ago. It is recorded that Gunter shortly after bringing out the trigonometric logarithm tables in 1620 placed logarithmic scales on wooden rules, and used a pair of dividers to add or subtract the logarithms. In 1627 these logarithmic scales were drawn by Wingate on two separate wooden rules, sliding against each other, and thus obviating the necessity of the dividers, and in 1657, or over 250 years ago, Partridge brought out the slide rule, which was, more or less, similar to the slide rule in its present form.

Fixtures Used in Machining Miller Parts

These Milling Machine Tools Handle Two Parts Which Are Cast in One Piece and Cut Apart After They Are Machined

BY A. J. BAKER*

The fixtures herein described, although embodying no strikingly new features are of interest by reason of the "two-in-one" principle, and also, as showing how collaboration between the machine and tool-designing departments promotes economy.

The first example, Fig. 1, is the "guide for knee," a detail of the Cincinnati High Power millers. It forms part of the column bearing of the knee and has to be interchangeable so that guides taken from stock will fit any knee.

There are four sizes of machine on which this guide is used, but only two sets of milling fixtures are required for their production, the guides having been so designed that one set together with its gang can be used for the two larger sizes, and the other set with its gang looks after the two smaller sizes.

Fig. 2 shows the way in which the guides are cast. Two are joined together, flank to flank, with a 3/16-inch space between for the separating saw cut; they are also provided with four lugs which are partially cut off at the first milling operation and entirely so at the third, thereby while providing adequate clamping points, adding nothing to the time required for milling.

The milling gang, Fig. 3, consists of two angular cutters, two side and face mills and three interlocking cutters. Of these three cutters the combination of Nos. 1 and 2 gives the correct distance for the No. 5 guide and Nos. 1 and 3 the correct distance for the No. 4 guide. The cutters are all so checked into each other that they may be set both for roughing and finishing cuts. A similar gang is used for the two smaller sizes of guide.

Milling Fixture for First and Second Operations

The milling fixture for the first and second operations for which the above gang is used, is shown in Fig. 4. It consists of a main casting, four clamps and six movable supporting points, of the four central ones are for support only, those at each end being for support and location. There are four locating points on which the lugs previously referred to, rest; of these, the three screws *A* are fixed and the screw *B* is movable. Immediately over these points are the four clamps. The work casting resting on these points is slid up to the end stop *C* which has two positions to allow for the different lengths of guide. The two support points *D* are then moved up, these being actuated by the beveled-end rods which are in turn moved forward by the screws projecting from the front of the fixture. The upper end of these support points is beveled off to approximately fit the groove cast in the work, and into which the separating saw cut is made. These points therefore, fitting in the groove, line up the work with the fixture. The clamps are now tightened onto the lugs, and the four central support pins moved up until they rest against the under side of the work. Thus supported at ten points there is but little opportunity for the work to chatter under the cut which is taken on a No. 4 Cincinnati High Power machine as shown in Fig. 5 at a feed of 6⅞ inches per minute.

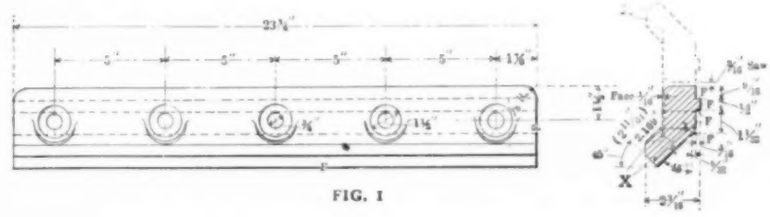


FIG. 1

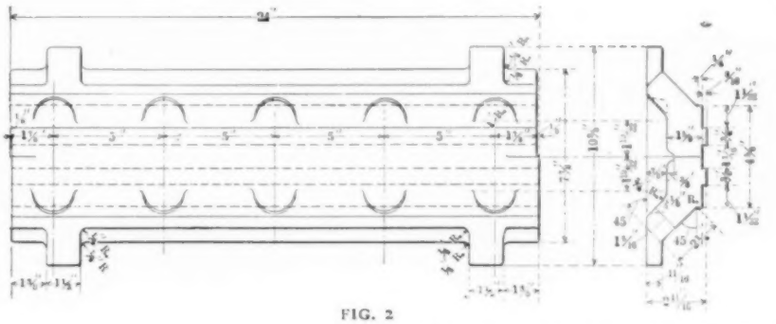


FIG. 2

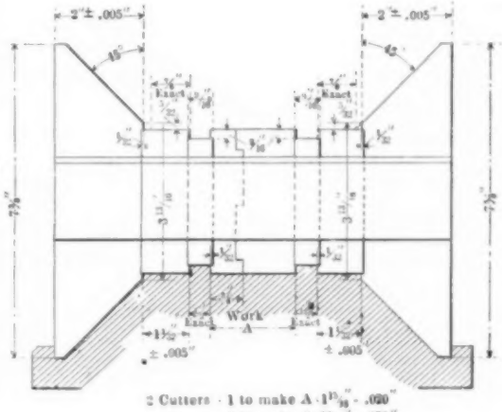


FIG. 3

THE GUIDE TO BE MILLED AND THE CUTTERS

Finishing Operations

After the roughing cut has been taken over the batch of guides the gang is reset to finish the tongues and flat surface but not the angular faces, which are reserved for the fourth operation. At first sight it would seem the simpler plan to finish the whole of the guide at this stage, but on account of the relatively large diameter of the angular mill any reasonable feed would give such deep feed marks that as much time would be lost in the scraping as would be gained in the milling. Furthermore, the accuracy required would call for much greater care, and consequently time, in the setting and grinding of the cutters both as to space and angle. As it is, the setting of the cutters involves only the retention of the dimension ½ inch. The feed in this case is 3½ inches per minute.

Other Guide Milling Fixtures

The third operation for which the fixture shown in Fig. 6 is used consists of milling faces *X*, Fig. 1, and sawing apart the two guides. The body of the fixture carries four clamps, two for each guide, with a space between each pair through which the saw may pass. Two grooves

*In charge jig- and tool-designing department, Cincinnati Milling Machine Company.

are milled in that face of the fixture on which the work rests; one of these grooves locates the tongue strip, the other is a clearance width. The gang which contains the two angular cutters used in the first operation together with two plain cutters and a 9-inch saw is shown in Fig. 7.

In Fig. 8 is shown the fixture for the last operation, a simple bracket with locating slot and clamps, it calls for no comment. A standard end mill is used with a table feed of 20 inches per minute.

Machining a Gib

The second example is a gib used on one of the Cincinnati millers. It is shown in Fig. 9. Varying in length, depth and thickness, but retaining the angles, this gib is used on the saddles and knees of all the machines manufactured by this concern. It will be obvious that a large number of these are required per annum, and equally obvious that the problem of holding such long and slender pieces in such ways that rapid and accurate milling may be done on them presents its difficulties.

Until recently these gibs were both cast and milled singly, but greater output rendered it necessary to improve on existing methods. To effect this improvement the gibs were all cast as Fig. 10 shows; that is, two together, flank to flank, but in place of a constant space between the flanks, the dimension from apex to apex of the triangles forming the upper half of the gib was kept the same. This meant that in the case of the smaller gib more metal was wasted in the separating process than was absolutely necessary, but counterbalancing this was the fact that one set of tools could then be used for the entire line of gibs.

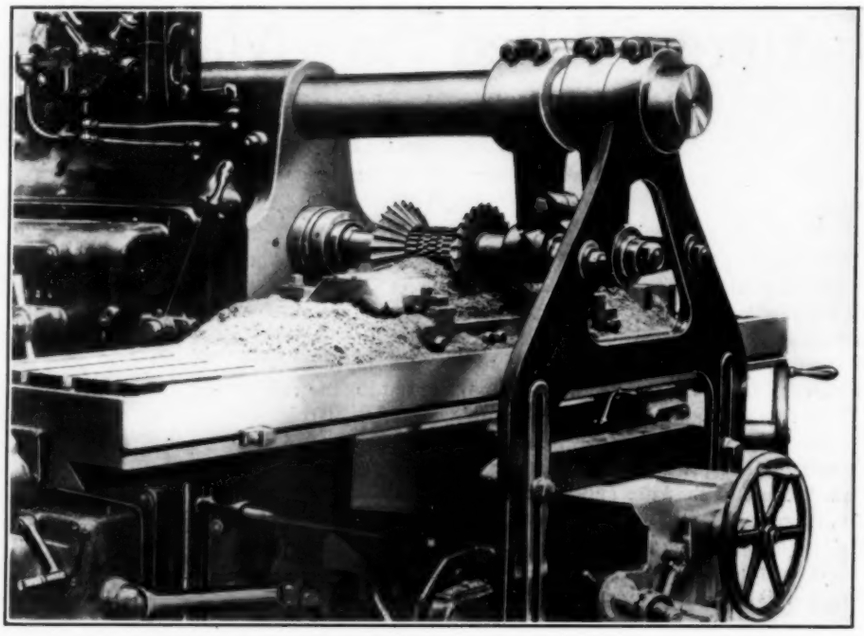


FIG. 5. MILLING A GUIDE CASTING WITH GANG CUTTERS

The double-gib casting was provided with lugs so spaced that they came opposite the jaws of the pneumatic vise described in the American Machinist, at page 872, Vol. 30, Part 2.

How the Gib is Milled

In this vise, then, the first roughing operation is performed, using the gang shown in Fig. 11, which mills the flat side,

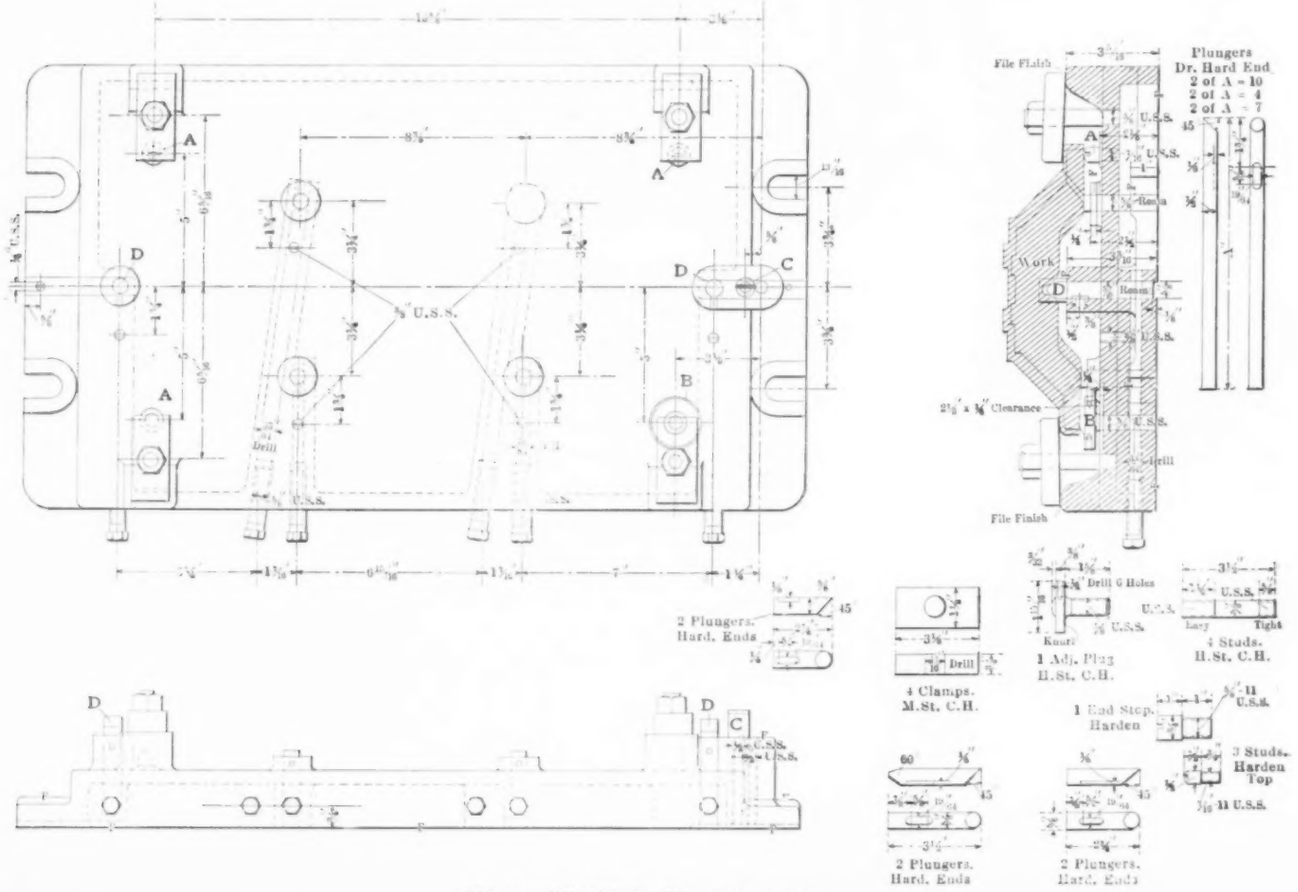


FIG. 4. MILLING FIXTURE FOR GUIDES

the edges, and partially separates the two gibs, at a feed of 6 inches per minute.

After this process the 3/8-inch holes are drilled and tapped, there being two or three such holes in each gib, according to its length. The holes are pitched equally and at the same distance from the apex of the triangle; a multiple-spindle drill is used.

By means of these holes the gibs are attached to the fixtures, shown in Fig. 12, of which two are provided. The screws *A* are smaller than the holes in the fixture in which they work, and the threaded portion is 0.010 inch smaller than standard in order that the screws may be easily and quickly inserted in the gibs.

In operation the workman fastens a double-gib casting to the fixture by means of the screws. The face machined in the first operation rests on the fixture which is held in the pneumatic vise. The gang used is shown in Fig. 13, and consists of three angular cutters, of which the two outer mill the remaining side of the gib while the central mill, cutting into the groove made at the first operation, separates the two gibs.

During the progress of this cut, which is fed at the rate of 6 inches per minute, the workman is attaching another casting to the second fixture which upon the completion of the cut takes the place of the first. The wide sheet-iron wings extending from both sides of the fixture are to receive the chips and prevent them from falling upon the gripping surface of the vise jaws. This enables the workman to remove one and insert another fixture without any of that loss of time usually consumed in clearing away chips and dust, and as a result it is possible for the machine to maintain an almost constant cut, giving it as a work producer great efficiency.

For finish milling the broad face of the gib the fixture shown at Fig. 14 is used. Mounted upon the table of a vertical milling machine is the base plate *A*. This plate has at one end an angular block, at the other an eccentric clamp with an

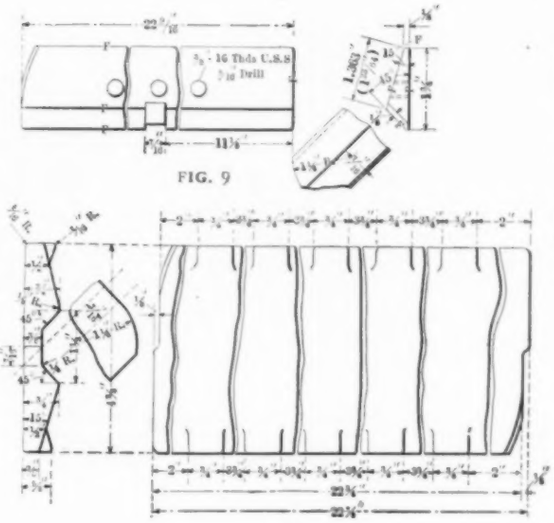


FIG. 9

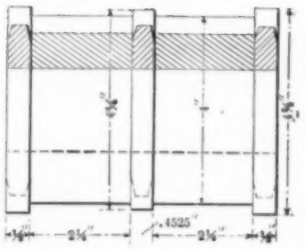


FIG. 11

FIG. 10

THE GIB CASTING AND MILLING CUTTERS

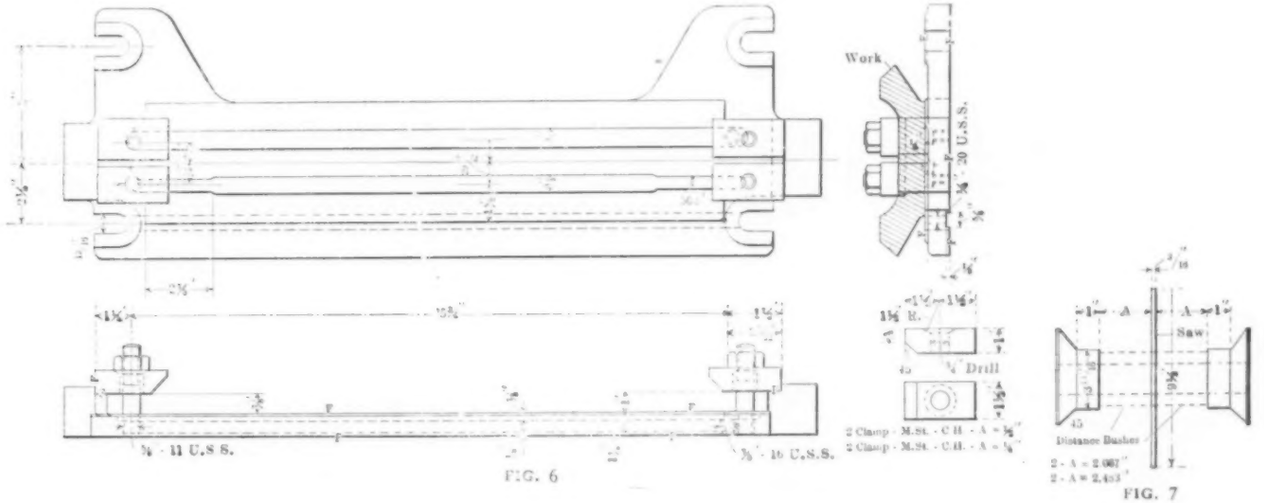


FIG. 6

FIG. 7

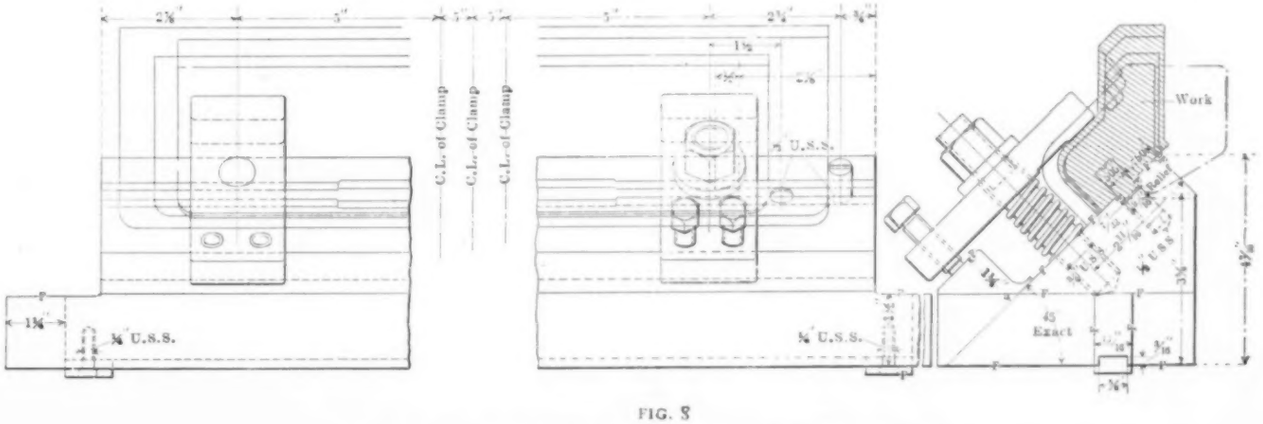
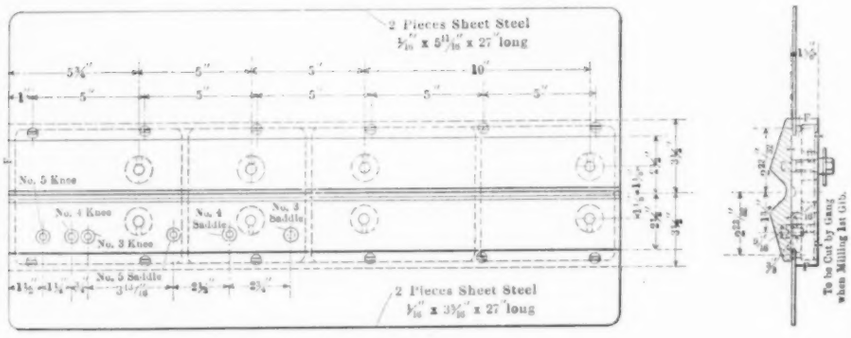


FIG. 8

THE GUIDE CASTING AND THE MILLING FIXTURE FOR LAST OPERATION



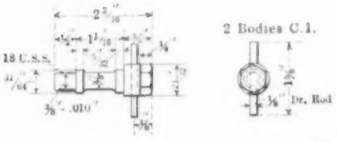
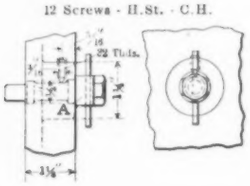


FIG. 12



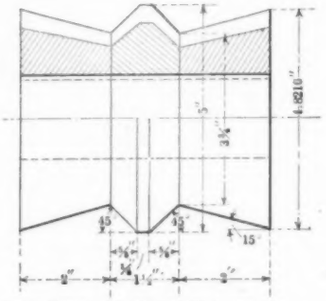


FIG. 13

GIB-MILLING FIXTURE AND CUTTERS

inclined locking face. This clamp forces the "loading fixture" *B* (there are two of these) down onto the base and up against the under side of the angular block, so securing it quickly and firmly in place.

The loading fixture is provided with screws similar to those used in the fixture before described, but only one gib at a time is operated on. The screws pull the gib down to its angular seat and so insure that the upper face shall be milled parallel with the lower. The sides of the fixture are inclined to guide the chips clear of the locating surface on the base which requires no cleaning on the part of the operator. This is of considerable importance in this case as on account of the high feed used (20 inches per minute) the operator is fully occupied removing and inserting the gibs.

It is, of course, the aim of this fixture to keep the machine almost continuously cutting, and any time spent in cleaning off chips would militate largely against its success.

Catalogs in the Technical School

By John B. Peddle*

I have sometimes wondered whether manufacturers, generally, realized the advantage to themselves of having their catalogs on file in the technical schools. Some few firms I know appreciate the value of the advertising they receive in this manner, for my department is in regular receipt of their catalogs and circulars, which are sent without solicitation; and I believe that the results, although they may not be immediately apparent, will, in the long run, richly repay the slight trouble and expense to sending such material.

I, myself, use many of the catalogs as illustrations of good design in my class work, and I find that they frequently contain valuable data which it is difficult to find elsewhere. By consulting the catalogs for these and other purposes the students (potential engineers) become familiar with the material to be had in the market and with the names of the firms supplying it. Moreover, the fact that I keep such trade literature on file is known in the school, and I have frequent applications from other departments for the names of firms supplying material or apparatus of which they may be in need.

I personally will gladly welcome and acknowledge any catalogs or circulars which have any bearing on my work (machine design), or on engineering work in general, such as machine tools, transmission devices (shafting, gearing, pulleys, belts, clutches, etc.), hoists and cranes, steam engines, gas, electric and water motors, materials of construction, etc.

*Rose Polytechnic Institute, Terre Haute, Ind.

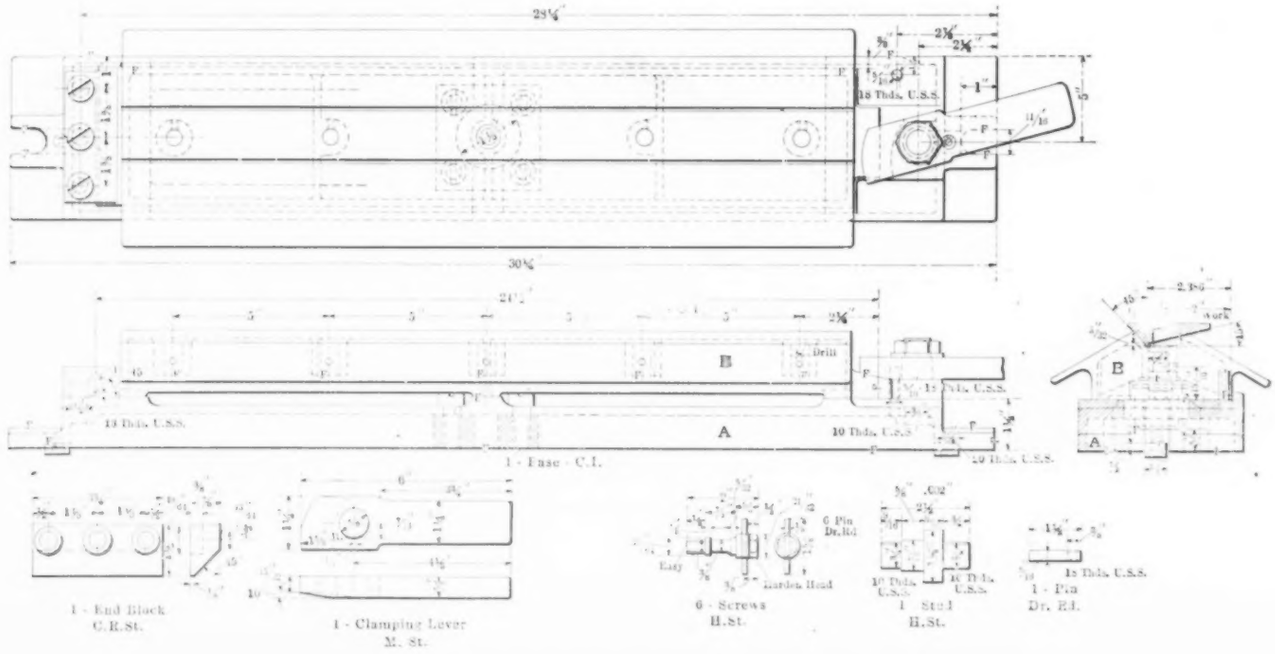


FIG. 14. MILLING FIXTURE FOR FINISHING GIBS

Interchangeable Involute Gear-Tooth Systems*

Discussion Favorable to the Establishing of a Recognized Standard for Interchangeable Involute Teeth by the Mechanical Engineers

BY MEMBERS OF THE A.S.M.E. AND OTHERS

ABSTRACT OF PAPER BY R. E. FLANDERS

This paper gives diagrams showing the effect of varying the pressure angle and addendum on the various practical qualities of gearing, such as interference, number of teeth in continuous action, side pressure on bearings, strength, efficiency, durability, smoothness of action, permanency of form, etc. After comparing typical examples of interchangeable-gear systems in these particulars, the author concludes that a new standard for heavy, slow-speed gearing is advisable.

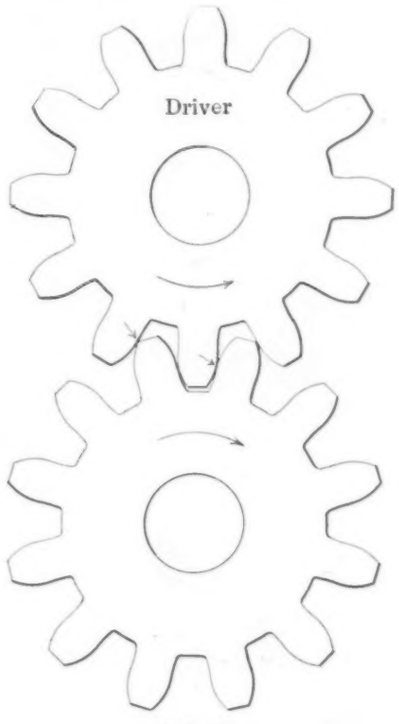


FIG. 1

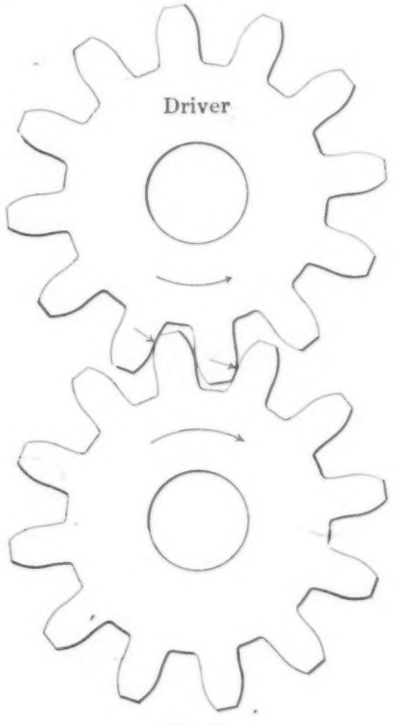


FIG. 2

TWELVE-TOOTH PINIONS, B & S. INTERCHANGEABLE 14½-DEGREE SYSTEM

BY WILFRED LEWIS

I think Mr. Flanders has presented a very illuminating and complete analysis of the conditions governing the intelligent use of interchangeable involute gearing from a 12-toothed pinion to a rack. It appears from this that the so-called standard 14½-degree system is really no system at all, but rather an evolution by a sort of trimming process from the errors of the past.

About 30 years ago when I first began to study the subject, the only system of gearing that stood in much favor with machine-tool builders was the cycloidal in which the describing circle was made one-half the diameter of a 12-toothed pinion, thus giving it radial flanks. At that time I was called upon to investigate a cutter-forming machine in which the faces and flanks of the cutter were approximated by circular arcs. I soon came to the conclusion that the true form of such cutters could not be approximated by circular arcs near enough to give satisfactory results, and I worked out a scheme whereby the machine was modified to form the faces and flanks each by two tangent arcs instead of one. Some improvement in action resulted from this change, but the gearing produced was still noisy, and this improvement was followed by the very radical one of building a cutter-forming machine in which the shapes produced were actually rolled.

For some time thereafter William Sellers & Co., with whom I was connected, continued to use cylindrical gearing made by cutters of the true shape, but the well known objection to this form of tooth began to be felt, and possibly 25 years ago my attention was turned to the advantages of an involute system. The involute systems in use at that time were the ones here described as standard, having 14½ degrees obliquity, and another recommended by Willis having an obliquity of 15 degrees. Neither of these satisfied the requirements of an interchangeable system, and with some hesitation I recommended a 20-degree system, which was adopted by William Sellers & Co., and has worked to their satisfaction ever since. I did not at that time have quite the courage of my convictions that the obliquity should be 22½ degrees or one-fourth of a right angle. Possibly, however, the obliquity of 20 degrees may still be justified, by reducing the addendum from a value of one to some fraction thereof, but I would not undertake at this time to say which of the two methods I would prefer.

I brought up the same question nine years ago before the Engineers' Club of Philadelphia, and said at that time that a committee ought to be appointed to investigate and report on an interchangeable system of gearing. We have an interchangeable system of screw threads, of which everybody knows the advantage, and there is no reason why we should not have a standard system of gearing, so that any gear of a given pitch will run with any other gear of the same pitch.

BY LUTHER D. BURLINGAME

I can easily believe that my friend, the author of this paper, found the solution of the interchangeable gear-tooth problem a task far greater than he had anticipated. While many writers appear to reach some rather definite conclusions, I believe that the usual experience of investigators along these lines has been voiced by Mr. Miller in the AMERICAN MACHINIST. "I think that it is the experience of most men that the more they have studied on the matter of tooth-gearing, the more clearly it has appeared to them that they would never be able to believe anything in regard to it." I take this opportunity to express my appreciation of the able and fair-minded way in which Mr. Flanders has dealt with so difficult a subject, and one that can be viewed from so many points.

Mr. Flanders bases his data for the 14½-degree pressure angle entirely on a form of tooth which is a true involute for its entire length. As such a tooth is not made or recommended by any manufacturers, as far as I know, and as what is made would give a radically different showing in the comparative tables of the paper, this seems to be setting up a "straw man" to knock over, rather than "tackling" the real thing. It can be said in extenuation that the author used the data at hand; that the data in commercial use were not available is not surprising, as they have

*Abstract from the *Journal* of the A. S. M. E.

been derived by manufacturers through years of experience and at great expense; furthermore, the giving out of such data, even were it good policy, most probably would never result in the production of good gears, much less of interchangeable gears. The experience of the company with which I am connected is that the old saying, "a little knowledge is a dangerous thing," is most applicable to the science and practice of gearing.

Certain paragraphs deal with the difference between the theoretical and the commercial tooth of 14½-degree pressure angle. These deal to a greater or lesser extent with the question of length of contact of the engaging teeth and with the question of the number of teeth in continuous action. To show the radical difference between the results obtained in the paper and based on the use of the uncorrected involute form of tooth with 14½-degree pressure angle, inadvertently called by the author the Brown & Sharpe system, and the results actually obtained with cutters made by that company, I would refer to Figs. 1 to 3. As a matter of fact there are two teeth driving for half of the time, or on a basis of Mr. Flanders' table referred to above, 1.5 teeth in continuous action. As his table gives 0.98 of a tooth in continuous action, the real Brown & Sharpe tooth shows a gain of more than 50 per cent. above the results tabulated as the Brown & Sharpe standard. If all of the statements in paragraphs and figures above referred to should be modified to this extent, they would give a real comparison instead of a hypothetical one.

The teeth of the gears cut with Brown & Sharpe cutters are slightly eased off at their points so as to come gradually into engagement, thus insuring smooth and quiet running. Experience has shown that such a modification is not only important but essential, and in any system, no matter what the pressure angle and hight of addendum, I believe the teeth should be so modified. When such a modification is made it becomes a mere academic contention whether the corrected part is modified from a true involute or something else. I understand there are methods covered by patents for accomplishing a rounding and easing off of the points of the teeth when they are formed by the generating process.

The impression is given by the author that there are difficulties in the way of using the generating process which limit it and that the devising of a new system of gearing will make its use more satisfactory. This seems like a case where, as the mountain will not come to Mohammed, Mohammed must go to the mountain. To consider the adoption of one system for gears made by the generating process and another for those made by the use of formed cutters, would be like adopting the metric system for calculations and the English system for the use of the workman, considering each as adapted respectively to these particular uses.

In the Brown & Sharpe practice, to meet their own needs and those of their customers, cutters and gears are made with pressure angles varying from 4 to 28 degrees, and with a hight of tooth ranging in both directions far outside of the limits discussed in Mr. Flanders' paper. It is an everyday matter to produce gears and cutters with such variations, and they can be made at least with equal facility, as compared with standard shapes, by the use of formed cutters. Such cutters, as made by Brown & Sharpe, for 20- and 22½-degree pressure angle, are for each angle interchangeable.

Mr. Flanders has given little consideration to the question of *backlash*, in fact has not mentioned it where he sums up the objections to using a greater pressure angle and less addendum. In many classes of work this becomes an important consideration and any system tending to increase backlash is objectionable. It is a common practice in making special gears for printing presses and other places where backlash must be reduced to a minimum, especially where the center distance of the gears must vary appreciably, to make the pressure angle as low as 4 degrees, and to increase the addendum to a greater length than standard. In any case, the greater the pressure angle the more backlash there will be with a given inaccuracy in center distance, a given variation in setting the cutter or tool when producing the gear, or a given amount of wear on the teeth.

There are indeed special cases where a greater pressure angle than 14½ degrees is sufficiently desirable for various reasons to offset the objections made. The Brown & Sharpe company uses on its machine gears with a greater pressure angle, when the conditions make it seem desirable, and they make such gears and cutters for customers whenever called for. These, however, are invariably made with a correction for smooth and quiet running, even when the pressure angle and hight of tooth are such that theoretically this would not be required.

The Reinecker generating machine has provision for easing off the points of the gears to prevent noise.

Frank Burgess, of the Boston Gear Works, says* regarding the hight of tooth, "A long tooth usually gives a better movement than a short stubby one.

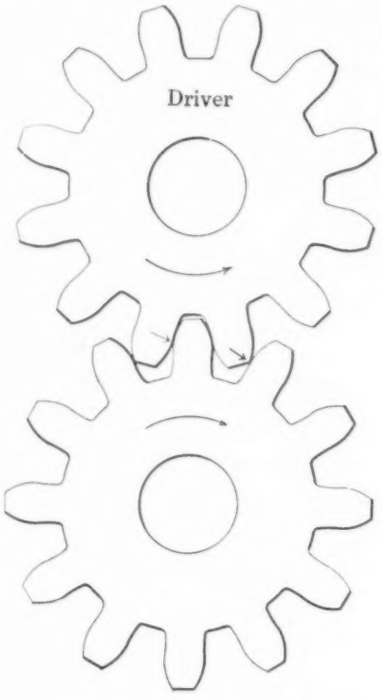


FIG. 3. BROWNE & SHARPE INTERCHANGEABLE 14½-DEGREE SYSTEM

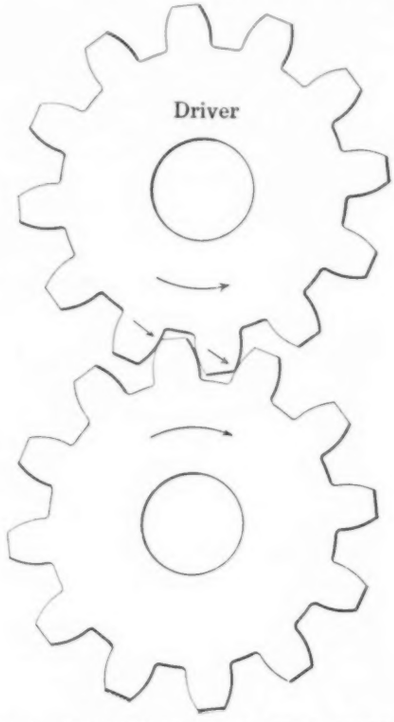


FIG. 4. PRESSURE ANGLE, 20-DEGREE DEPTH, 0.7 PITCH

With the shorter tooth, the pitch is proportionately greater for its depth and there is a tendency to jump from one to the other, especially for a pinion with less than 20 teeth, and this tendency results in noise. The noise in gearing is undoubtedly the result of shocks, jumps and vibration caused by teeth coming into and going out of action."

While the use of shorter teeth or a finer pitch would theoretically make some saving in time of cutting, we do not find such a saving appreciable.

With all our experience at the Brown & Sharpe works, our experts feel that the subject of gearing is full of pitfalls, and the more experience we have, the less we feel like dogmatizing or appearing as authorities. While all theories should be

*AMERICAN MACHINIST, Volume 30, Part 1 page 935.

examined with an open mind, I believe that a spirit of conservatism should govern their investigation until they are proved by practical experience to be correct.

I do not understand that the author suggests an abandonment of the present system, but states rather that the "discussion points clearly to the wisdom of an alternative gear tooth standard of shorter addendum and increased pressure angle." The fact is that modified forms of teeth, of a sort approved by the author and many other forms also, are now used in special cases where they prove to be better. Every manufacturer of gear cutters knows this to be true, though at the present time, with the large demand for gears in automobile construction, there may be an emphasis upon a tooth of a certain form. What this emphasis will be in future years is uncertain. As likely as not another pressure angle and another form of tooth may be insisted upon. Is it not better to leave these matters to the manufacturers of gear cutters and gear-cutting machines who are willing to give the public what they want rather than attempt to formulate a system which the experience of the next few years may possibly render of little value?

By D. F. Nisbet

I agree fully with the author's conclusion that an alternative standard of involute teeth for heavy, slow-speed gearing is desirable; particularly so for such gearing as rolling-mill pinions, where, owing to the limited diameter and tremendous shocks, it is necessary to use few teeth of large pitch, and obtain a comparatively smooth action by making the gears either double-helical or of the staggered-tooth type.

Smoothness of action, as understood and defined by builders of the finer classes of machinery, is not essential for rolling-mill work; perhaps continuity of action would better express the desideratum for this class of work. All that is necessary is a degree of smoothness of action that will not leave traces of "harsh gearing" on the finished product. This applies with particular force to plate mills and sheet mills, and in a lesser degree to all types.

By Charles Wallace Hunt

It should be borne in mind that this paper treats of a system of interchangeable gears; that is, all of the pinions and gears of each series having the same addendum. This commercial requirement eliminates the consideration of theoretically perfect forms of conjugating teeth for special conditions and confines the discussion to what Wilfred Lewis designates as the "best compromise between conflicting conditions."

Perfectly formed teeth are seldom made and cannot long be maintained owing to wear of the tooth faces. The chief disturbing factors are the shop errors in the pitch diameters of the gears and in the shaft-center distances. Such construction errors are unavoidable and so must be tolerated. Some factors partially offset each other, such as the tension caused by the friction of the sliding surfaces of the tooth after passing the center which weakens the tooth. The fillet at the root of the tooth strengthens it. Usually the favorable and the adverse factors partially balance each other, but the working formula must provide for the unexpected which, as Professor Sweet reminds us, frequently happens. After considering and valuing the various factors that affect the problem, the designer will decide on proportions that, in his judgment, will give the best general result in practice.

In the gear work of the C. W. Hunt Company it is assumed that the angle of action is 14½ degrees; the whole load is carried on one tooth; a pinion with less than 19 teeth should not willingly be used; if the pinion is strong enough its conjugating wheel is also; a table is quicker and safer to use than a formula; a table based on fiber stress is preferable to one based on the names of materials.

The total length of teeth frequently referred to, expressed as a percentage of the circular pitch, is:

Rankine	0.75
Sir Wm. Fairbairn	0.70
Brown and Sharpe	0.687
Molesworth	0.66
Coleman Sellers	0.65
Hunt	0.55

After 10 years' use in a wide range of machinery, I believe that for commercial machinery the following proportions for cut teeth are especially suitable ones. If they are not ideal proportions the difference is slight. The face of the tooth is involute in form, the angle of action is 14½ degrees, and the length of the tooth is 0.55 of the circular pitch.

HUNT TOOTH FORMULA.

Addendum	0.25 of the circular pitch.
Dedendum	0.25 of the circular pitch.
Clearance	0.05 of the circular pitch.
Length of tooth	0.55 of the circular pitch.

Table 1 gives the working strength of a spur tooth having parallel flanks. The tabular load applied on the pitch line produces a fiber stress at the root of the tooth of 5000 lb. per square inch. If applied at the pitch line plus one-half of the addendum then the fiber stress will be 7100 pounds. If at the extreme end of the tooth 9200 pounds per square inch.

For a safety factor of 3½ when the load is applied to the end of the tooth: Cast iron (16,000 pounds ultimate strength), use a working load of one-half the tabular number. Steel (64,000 pounds ultimate strength), use twice the tabular number.

Diametral pitch	1	1¼	1½	2	2½	3	3½	4	5	6	7	8
Circular pitch	3.14	2.51	2.1	1.57	1.25	1.04	0.897	0.785	0.628	0.524	0.449	0.393
Pounds on the pitch line	2250	1800	1500	1100	900	700	600	565	450	375	300	282

TABLE 1. WORKING LOADS.
Spur Gears, One Inch Face.

Gear Cutters

The initial stresses in the casting frequently cause a distortion when the gear is finished. A spoked gear-wheel blank may be turned perfectly round in a lathe, but after the stocking cutter has been used the points of the teeth are seldom in a true circle. The rim between the spokes either bulges out, or falls in, depending on the initial stresses in the metal. This is frequently a material amount and is objectionable as it alters the pitch line and the tooth spacing, and also injuriously affects the clearance.

It has been found advantageous to have tooth cutters (Fig. 7) with a wing on each side which will trim the length of the teeth to the standard size. With these cutters a gear made of metal without a hard scale can be cut without sizing the blanks in a lathe.

Cutters for teeth proportioned by the above formulas are made for anyone desiring them, by Brown & Sharpe, Gould & Eberhardt, or any other gear-cutter maker.

By Oberlin Smith

The suggestion has been made that a committee be appointed to standardize gear teeth, with the assumption that there would be one standard. Another has said that it is best to leave it to the makers, as they know the needs of their customers; the result of this would be 40, or 50, or even 100 standards, as we have now. It would seem wise to standardize the teeth, even if there should have to be several kinds. We need to do this almost as much as we needed to standardize the screw thread. It would be useful to have some standard which most people would follow, and undoubtedly in this way a standard practice could be established. The committee would consider the different conditions, as for instance, those met in heavy rolling-mill work, and choose different pressure angles adapted to each case.

If a committee is appointed to consider this matter, I hope they will take out fractions and make the angle of obliquity 15 degrees rather than 14.5 degrees. Suppose they found 15 degrees good for a certain class of gear, and 20 degrees good for another class, and 25 degrees good for another class, why could we not have two or three standards, under certain

names, so that people could use them to comply with the conditions?

If we do have a committee on gearing, their investigations should go farther than merely determining shape. It would be well to instruct them to find out all they can about strength of gears as well. The matter of strength is very important, and it is a thing which we do not know very much about. Many of us go by the Lewis formula, by which, it seems to me, the required strength increases too rapidly with increase in speed. But there are conditions of impact and percussion which cause the teeth to vibrate and make them break at high speed. We do not know what these conditions are, and that is what the committee should find out.

One thing desirable, in interchangeable gearing, is to be able to use fewer teeth in pinions. Someone said that nine is the lowest number desirable. The Brown & Sharpe Manufacturing Company gives 12 as the least practical number to get a theoretically good wheel, and very likely that is so. I have used pinions with four, for some 15 or 20 years, without perceptible wear where the pressures were not great but the speeds were very high, the small pinion being the driver. I have some lathes which have five-tooth pinions doing the driving; they are still in use and are a perfect success. Of course, it is probable that the angular motion is somewhat irregular with such a small pinion.

It is often practicable to use a pinion with from five to ten teeth, as a driving, but not as a driven gear. It is well to avoid "strain" of several gears by using only two, having the pinion as small and gear as large as possible. It is often good practice to cut such a pinion in the solid shaft. We are building some heavy presses, of 1000 tons capacity, where the pinions are more than a foot in diameter, forged integral with the shaft, one at each end. A common practice in rolling mills is to use two helical pinions separately keyed on, with pitch reversed to avoid end thrust and ends abutting. I recently built a mill for a foreign government, with two 16-tooth pinions forged solid with their shafts where two projecting collars served as blanks for the pinions, and by the simple expedient of separating them, left room for a Brown & Sharpe cutter to run through, into the space between.

By Charles H. Logue

After reading Mr. Flanders' paper, it would be useless for me to enter a discussion as to the need of a universally accepted standard for gear teeth, especially for large gears. It is now common practice for all users and makers of large gears, to correct the teeth for interference, either by shortening the addendum or increasing the angle of obliquity as compared with the 14½-degree system, or both. This procedure, of course, entails additional expense in manufacture, as special cutters and formers must be made for each gear. Again, each manufacturer, and in many cases the individual user has his own ideas as to how this correction for interference should be made, and also as to the amount.

I wish to express my approval of the purpose of Mr. Flanders' paper, namely: the appointment of a special committee of the society to recommend an interchangeable gear-tooth standard, and also of the action at the last meeting of the society whereby a recommendation was made to the council that such a committee be appointed. The present situation is little short of chaotic, and the present "so-called" standard was most aptly characterized by Wilfred Lewis as "no standard at all." The work before this committee is mountainous, for this problem is probably more complex than any other individual problem in machine design and construction that could be presented. The difficulty of the problem is also a measure of the benefit that will come to the machine-building industry if a standard is recommended and brought into general use.

It is apparent that there will be a great saving in the adoption of a rational, universal system, as well as an improvement in tooth action, the extent of which is entirely unappreciated by gear users. Only a comparatively small part of the gear-tooth surface is in actual use, and the rest of this surface is a detriment rather than a help to the tooth action. In addition to this detriment, the correction, as sometimes made produces surfaces that give an irregular impulse, or series of impulses, to the driven gear by the driver. Thus the teeth of the driven gear have instantaneous accelerations and retardations and lack a regular motion. This, of course, tends to destroy the gears rapidly. I believe that this condition prevails to a greater or less extent, in all involute gears as ordinarily made.

Proposed Short-tooth Standard

In order to set before the society information as to existing gear-tooth systems, I propose to describe a short-toothed, 20-degree standard that I began to use some three years ago. Since that time I have advocated this system for all gears heavier than one-diametral pitch, and in many cases for gears of finer pitches. I now see no reason why this system is not universally adaptable. It follows closely the Fellows system as worked out for fine pitches, except that the addendum bears a definite relation to the circular pitch. This relation is expressed by the equation,

$$addendum = 0.25\ circular\ pitch.$$

This quantity was derived from experience and from a study of the tooth parts of the Fellows system. In the Fellows system the addendum varies from 0.264 of the circular pitch to 0.226 of the circular pitch. These factors for the common combination pitches are shown in the following tabulation:

For 2[2½ pitch, addendum 0.255 of circular pitch
For 2½[3 pitch, addendum 0.264 of circular pitch
For 3[4 pitch, addendum 0.240 of circular pitch

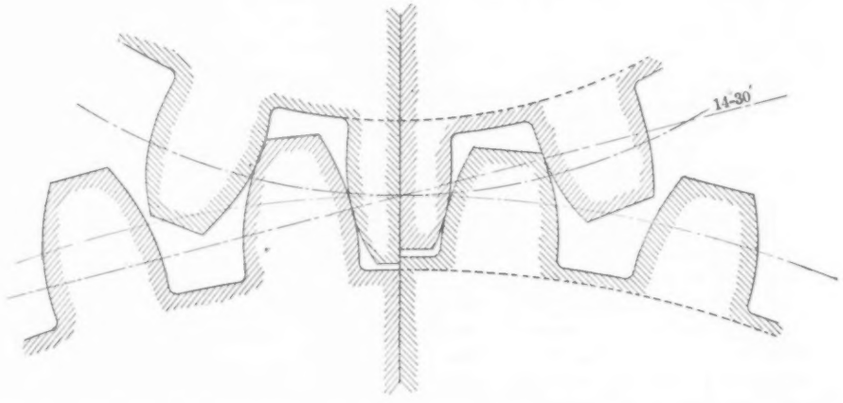


FIG. 5. DIAGRAM SHOWING LONG AND SHORT TEETH WITH THE PITCH LINE IN COMMON

For 4[5 pitch, addendum 0.255 of circular pitch
For 5[7 pitch, addendum 0.228 of circular pitch.
For 7[9 pitch, addendum 0.247 of circular pitch.
For 9[10 pitch, addendum 0.254 of circular pitch.
For 10[12 pitch, addendum 0.264 of circular pitch.
For 12[14 pitch, addendum 0.226 of circular pitch.
For 14[18 pitch, addendum 0.250 of circular pitch.

The factor 0.25 is, therefore, a rough mean of the factors shown in the table, and is also a convenient quantity to use in computing gear-tooth parts. This latter advantage is especially true as the thickness of the teeth at the pitch line, added to the pitch diameter, gives the outside diameter, and this relationship is of convenience when measuring gears in which the pitch diameter and pitch are unknown. In many cases the only dimensions received by the gear manufacturer are the outside diameter and number of teeth. While this feature should not be an influence in determining the length of addendum to be used, it is a convenient point to keep in mind. For diametral pitch the addendum is found by dividing 0.7854 by the pitch. This is a well known factor; is equal to $\frac{\pi}{4}$; is in general use

in many engineering formulas, and is easily memorized.

The tooth parts for circular pitch are:

Addendum	0.25 × cir. pitch, instead of 0.3183
Dedendum	0.30 × cir. pitch, instead of 0.3683
Working depth	0.50 × cir. pitch, instead of 0.6366
Whole depth	0.55 × cir. pitch, instead of 0.6866
Clearance	0.05 × cir. pitch, same as now used.

Addendum	$\frac{0.7854}{P}$	instead of	$\frac{1}{P}$
Dednedum	$\frac{0.9424}{P}$	instead of	$\frac{1.57}{P}$
Working depth	$\frac{1.5708}{P}$	instead of	$\frac{2}{P}$
Whole depth	$\frac{1.7278}{P}$	instead of	$\frac{2.157}{P}$
Clearance	$\frac{0.157}{P}$	same as now used.	

In addition to the length of the addendum the other important element of the gear tooth to be determined is the obliquity. While the increase in journal friction with the pressure angle is not as great as is generally supposed, yet this angle should be kept as small as is consistent for the purpose intended; that is, to obtain an interchangeable involute system without correcting the tooth outlines. In the system which I am describing, 20 degrees is the angle of obliquity. Thus the two essential elements of the system are, the addendum equal to 0.25 of the circular pitch and the pressure angle of 20 degrees. These correspond very closely with Case 4, as set forth in paragraphs 44 and 45 of Mr. Flanders' paper. He characterizes Case 4 as a system having an angle of obliquity of 20 degrees and an addendum hight equal to $\frac{0.8}{P}$. For circular pitch the addendum would equal 0.8 or 0.2513 of the circular pitch. That is, Case 4 is essentially the system which I am describing.

Referring to paragraph 45 of Mr. Flanders' paper, from his tabulation captioned, "Comparison of Selected Examples of Involute Gear Tooth Systems," I have transcribed the factors:

Smallest pinion, in series, to avoid interference	14
Maximum number of teeth without correction for interference with 12-tooth gear	36
Maximum and minimum number of teeth in continuous contact	{1.38 / 1.18
Proportion of side pressure on bearing to tangential pressure	1.064
Strength-factor of rack	0.543
Strength-factor of 12-tooth gear	0.354
Comparative loss of work from friction	552
Comparative durability	1.44

He states that the smallest pinion in the series that can be used and avoid interference is one with 14 teeth. The lowest theoretical number of teeth for such a pinion engaging a rack is 13.4. I believe, however, that 13 teeth can be used without correction as the error is less than one-half a tooth; therefore, in order to use a 12-toothed pinion, which is today considered a *desideratum*, the only correction necessary is for this pinion alone. In some practice, street-railway use in particular, 14 is the smallest number of teeth which is ever used; 12 and 13 are always avoided.

In order to use an uncorrected 12-tooth pinion in this instance, without changing the addendum, it would be necessary to increase the angle according to Mr. Flanders' formula, to 21 degrees 13 minutes. If it is necessary to include the 12-tooth pinion in the interchangeable system, I would prefer to see the angle increased for the reason which I have indicated above. However, I would strongly recommend for consideration an angle of 20 degrees and the addendum as given, and thus consider a 12- and perhaps a 13-toothed pinion as special. These would then be in the same situation as are 10- and 11-toothed pinions today.

It will be argued that the short-tooth standard permits of a smaller number of teeth in contact. While this may be true, in some cases, the superiority of this contact has been demonstrated by Mr. Flanders. However, it should be noted that, owing to the increased strength of the tooth that has been shortened and has a wider angle of obliquity, the pitch may be reduced accordingly to give the same number of teeth, or more, in contact, as are in contact in similar gears having the usual length of addendum and a pressure angle of 14½ degrees.

As a matter of interest it must be pointed out that this system is now in use for the gears of the subway trains in New York, and to the best of my knowledge it is superior in service to the standard-toothed gears that have been discarded. The special 20-degree involute stub-tooth system described by Mr. Litchfield in his paper on "Spur Gearing on Heavy Railway Motor Equipment," is the same as this short-tooth 20-degree standard that I have proposed for consideration.

By E. R. Fellows

The conclusions arrived at by the author do not entirely coincide with my experience. The reason is that the form of 14½-degree tooth considered is virtually a short tooth of this angle, and has theoretically, in these deductions, some of the advantages of the stub tooth. The forms selected by the author for the standard or 14½-degree tooth are those which he infers are produced by a set of formed milling cutters designed to cut an interchangeable set of gears. As, however, the exact form of these cutters is more or less of a trade secret, he has evidently been obliged to make his own deductions upon some points, such as the exact modification for interference and the angle of the flank below the base line. A little variation in these points makes a considerable difference in theoretical efficiency.

The stub tooth so-called, which is a short tooth of 20 degrees, being very little modified for interference, conforms very closely to the theoretical. The standard forms selected give n, the number of teeth in contact, as 0.98. It has been the general experience that gears having a line of action as short as this do not run satisfactorily; they are noisy. And this is the test by which gearing is approved or condemned, a difference of one or two per cent. in efficiency being of no importance whatever. An examination of any satisfactory set of gearing of standard form will show that most of the gears bear nearly if not quite to the point. This means that the value of n is ordinarily 1.5 to 1.75, and while the running qualities are satisfactory the efficiency is lower than if the value of n were 0.98.

This being the case, it is safe to assume that either the form of standard cutters ordinarily used is not the one discussed by the author, or that gearing, after running a short time, changes from wear sufficiently to give a longer line of action. The author evidently had this condition in mind, as his formula for strength assumes that the stress is applied at the extreme point of the teeth, notwithstanding the fact that according to his first deductions, this would be impossible. We will consider the changes necessary to give to n the value of general practice.

The design of cutters for an interchangeable set is a matter of compromise. Strength demands as broad a flank as is possible for the pinion; efficiency demands a short line of action; quiet running requires a longer one. The latter being the point by which the user tests his gears, it is safe to say that it receives the most consideration. A little compromise would obviate even the undercutting of the flank.

Theoretically, in the interchangeable set two pinions of 12 teeth should mesh together. Practice does not demand this, such a case being extremely rare. This combination would give a very low efficiency. If this is imperative, as in the case of spur-gear differential of the automobile, gears of greater angle are almost invariably used. It is safe to say that the meshing of two 15- or 16-tooth pinions would fulfil all practical requirements, and anyone who has rolled two standard pinions of 12 teeth together, in the condition which they leave the cutter, will decide that in practice all gears are not absolutely interchangeable.

My experience has been largely with generated gears, but from this experience, I would say, that the less practice in gearing of the standard form demands a length of action giving about $n = 1.5$, and that this requirement is met. This value of n would materially change most of the diagrams given. If the modification for interference of the standard 12-tooth pinion, instead of being 0.4 of the addendum, be 0.0, and if this modification up to about 30 teeth be a very immaterial amount, the friction or lost work of the average train of gears will be considerably more than that given by the author.

In this connection the term "corrected for interference," used by the author and by other authorities on gearing, is open to criticism. As the involute curve is theoretically correct, and after "correction" is only *correct* in the sense that it will mesh with another form which is not in itself theoretically correct, the term "modified" more nearly describes the case.

The writer would emphasize the statement regarding durability. The fact that wear, in the case of the stub tooth, is distributed over a much greater surface, is a strong point in its favor. This is more marked in the case of the pinion, where most of the wear usually takes place. The result is, that the form of the worn-out stub tooth is practically that of an involute curve.

The "handicap" of "one form of generating process" is not as serious as might be inferred. As the modification for interference is very simply taken care of by the design of the cutter, it is possible to vary this modification automatically, and to give the teeth of each diameter of gear just the required amount and no more.

One important point not touched by the author is the effect of what may be termed "shop efficiency" upon the comparative running qualities of the standard and the stub-tooth systems. A shop efficiency of 100 per cent. is possible only under laboratory conditions. Ninety per cent. represents what is probably first-class commercial conditions, and 70 per cent. is more common. The running qualities of both types of gear would probably be very nearly the same under laboratory conditions, but under practical ones the balance is in favor of the stub tooth and increasingly so as the shop efficiency decreases.

By Thomas Fawcus

We find the Brown & Sharpe system sufficient in every respect up to 1 P. For large gears we generally use the 20-degree involute, with a depth of 0.55 of the circular pitch, or about 0.8 S. A layout for some 5½-inch pitch gears recently made is shown in Fig. 1.

The gear manufacturer is usually in the unfortunate position of having to assume responsibility for gears designed by others for work of which he is not informed. If the gears fail, it is blamed on the only detail left to his discretion; namely, the kind of iron or steel or other material used. A recent case where material was blamed for being "too soft," upon investigation showed gears put to a service calling for nearly four times the strength by Lewis' formula. For these reasons I think the question of durability has not received sufficient attention. Tooth forms do not trouble gear manufacturers much; it is easy to make conjugate involute teeth, and, for heavy gears at least, the short tooth is preferable. But we need to know more about the durability of certain combinations of metals at high and low speeds. This is most important in gears under heavy load and at low speed where the material must be such as will not crush on the line of contact; also in worm gearing, which is in a class by itself with regard to the materials of which it should be made. The usual practice of making the worms of steel and the wheels of cast iron is very bad. But if the gear-maker offers any objection, he is confronted with the fact that the combination has proved satisfactory in some particular case. That results are most varied and even contradictory is true; one pair of worm gears succeeding where a perfectly similar pair will fail. This is sometimes partly explained by excessive friction caused by tight bearings in new machines, or shaft centers too close together, or insufficient lubrication. The cutting action once started is difficult to stop and usually results in the destruction of the wheel.

This is, I know, departing somewhat from the subject under discussion, but I mention it because it is a very real difficulty with which engineers and manufacturers have to contend.

By Prof. F. DeR. Furman

At the end of paragraph 12 the author states: "In Fig. 7, it will be seen, a similar increase of addendum makes no change in the number of teeth in contact, as the action is still limited by points *C* and *D*." In paragraph 15 it is stated: "When $\alpha = 20$ degrees and $S = 1.0$, the amount of contact between any two gears of the same series from 12 teeth to a rack is constant at about 1.4" and also "that if in any series there is interference in the case of two pinions having the smallest number of teeth allowed by the series, the amount of action obtained in that case is constant for any other case throughout the whole series, up to that of two racks meshing with each other. As far as the author knows, this condition has never before been noticed." Also in paragraph 15 we find: "The 14½-degree standard series of whatever hight of addendum gives less than continuous action, being about 0.987."

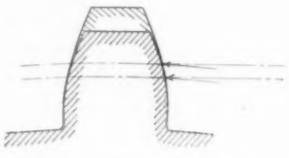


FIG. 6. DIAGRAM SHOWING A SHORT TOOTH SUPERIMPOSED ON A LONG TOOTH WITH THE ROOT LINE IN COMMON

All the above statements must rest on the assumption that there is no contact between the tooth surfaces beyond the interference line, in which case there is a fair portion at the end of the tooth that could be cut off without interfering in any way with the running. If a set of interchangeable wheels were made with conjugate extensions beyond the interference line none of the statements quoted would hold. Since the extension cannot be involute, and must be of some other form, that form might as well be the simplest one, which is the epicycloidal. And further, if we give the epicycloidal form to a fair portion of the face, and flank, and leave only a portion of the tooth near the pitch circle, of involute form, we may as well abandon the involute system entirely for interchangeable gearing, and adopt the epicycloidal system instead for interchangeable work.[1] Then in the endeavor to perfect gearing we could at least work toward theoretical conditions, instead of using the approximate methods for forming the extensions to the involute beyond the interference line. These extensions, I understand, are not in practice true conjugate curves, and, therefore, must allow, theoretically at least, the follower to slow up while the driver continues at its uniform velocity, the result being a blow as the teeth come into contact.

The author shows that in a system having an angle of 22½ degrees or more, and where $S = 0.8$, there is no interference, and it follows that the teeth may be correctly made of the involute form all the way to their tips. But even here smoothness of action will not be obtained so long as the teeth are cut with standard rotary cutters in which each one must cut a certain range of wheels. Take for example the No. 3 cutter cutting 35 to 54 teeth; it would follow that the cutter must be formed to suit the involute of the smallest wheel, and, therefore, would cut away too much of the face of all wheels having 36 to 54 teeth. This means that there will be correct driving contact only at or near the line of centers, and as the driving pair pass through receding action the follower slows up, thus allowing the next tooth of the uniformly moving driver to come into violent action with impact and noise, instead of easy contact with the follower tooth.

In paragraph 24 the author states that "in order to get the proper form of fillet on the 12-tooth pinion, the rack tooth was lengthened by an amount equal to the clearance, and the corner of the extended tooth was rounded with a radius equal to two-thirds of the clearance." I would like to ask why the author goes to the trouble of lengthening the tooth and then rounding it off instead of simply finding the curve traced by the corner of the rack tooth on the revolving plane of the pinion and then placing the fillet curve within the one thus found?

From the present paper it would seem that there would always be difficulty, if not impossibility, in producing a series

[1] To meet the difficulty involved in cutting epicycloidal teeth at the pitch circle, we could adopt a combination outline for interchangeable teeth in which the tooth form is involute for a short distance on either side of the pitch line and epicycloidal for the remainder of the face and the flank.

of smooth-running interchangeable gear wheels, all the way from a 12-tooth pinion to a rack on the involute system. If a series of intermediate-sized changeable involute wheels were desired the problem would appear to be an easier one.

The most difficult part of the problem for interchangeable involute wheels lies in the fact that the face or addendum must be the same throughout the series. It is quite different, however, for an independent pair of wheels which are always to run together. Here the addenda may be made unequal to great advantage, thereby avoiding in most cases the trouble due to interference, and giving a receding action greater than the approaching by any desired amount. This involves the making of a special cutter for each wheel, but where a large number of wheels are to be duplicated the extra expense for cutters would be more than offset by the smoothness due to correct theoretical action.

An example of the use of teeth having unequal addenda will be given in a discussion of Mr. Litchfield's paper to be presented this morning. In that illustration it will be shown that a very strong tooth may be obtained with a 14½-degree pressure angle because: (1) The necessary amount of action may be obtained with this angle by a relatively short tooth; (2) a specially formed large fillet may be placed at the root.

From the above and from deductions from Mr. Flanders' paper, it would appear that if we give to high-class gearing the special consideration which each case deserves, theory is pointing to the use of a small pressure angle for two wheels that are to run always together, and to a large angle for a series of interchangeable wheels, if the involute system is used.

By A. L. DeLeeuw

The main point which has been made perfectly clear to me is that there is some difference of opinion on this subject, which is of some significance as showing that many of us have reached a point where we are striving for something different, supposing it to be better.

The motion by Mr. Lewis is to the effect that the council be requested to appoint a committee to consider a standard system of gearing. I am inclined to think this motion should be broadened by making it read "standard systems" instead of "a standard system." Not necessarily that we wish more than one system, but that it would leave the committee which investigates the matter free to consider it from all possible angles. I will, therefore, second the motion of Mr. Lewis and ask him kindly to assent to my suggestion to broaden the terminology slightly so as to include any kind of system or systems which may be proposed.

Mr. Lewis accepted this suggestion with the proviso that the resolution should be confined to involute interchangeable gearing; and also a suggestion by E. H. Neff that it be put in the form of a recommendation to the council that they take action upon its provisions. The motion which is expressed by the following, was then put and unanimously carried:

Resolved, that the council be asked to appoint a committee to investigate the subject of interchangeable involute gearing and recommend standard, or standards, if found desirable.

Closing by the Author, Mr. Flanders

Referring to paragraph 2 of Mr. Burlingame's discussion, it should be noted that I did *not* base my data on a form of tooth which is a true involute for its whole length. In fact, a main point of the investigation was to show how little of the outline (about one-third) could, in the standard form, be involute. This is one of the grounds for criticism of the present form of tooth, which thus relinquishes,

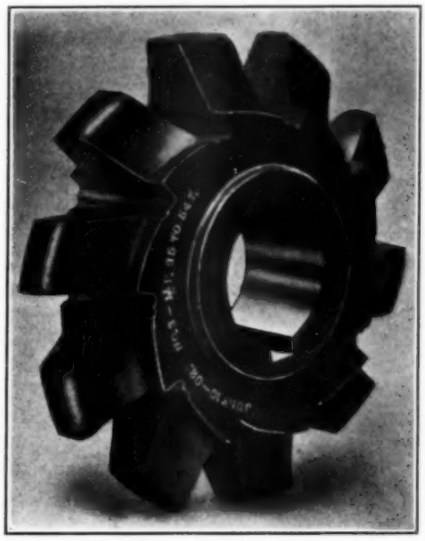


FIG. 7. PERSPECTIVE VIEW OF A GEAR CUTTER FOR TRIMMING TOPS OF TEETH

to a great extent, the advantage which the involute curve gives, of perfect action at varying center distances. Besides, the small length of theoretical curve possible makes the form of tooth indeterminate, except by empirical methods. I followed an old suggestion in making the indeterminate portions of cycloidal form; this was done only in order to obtain a reasonable working basis from which to start the investigation, and was made necessary by the lack of definite information from the proprietors of the present system. I apologize for calling this hypothetical system the "Brown & Sharpe" system. This was an inadvertence; proper correction will be made before the paper is published in a permanent form.

In paragraph 3, Mr. Burlingame objects to basing the calculations for the number of teeth in contact, etc., on the small amount of theoretical action possible with this hypothetical tooth form. (And this in spite of his previous assertion that the calculations were based on a tooth of true involute form for their whole length.) This procedure is justifiable, since, in a partially involute form of tooth, only the involute portion remains in action if the center distances (as must be expected to happen in practice) are slightly greater than called for theoretically.

It is true, as intimated by Mr. Burlingame in paragraph 7, that the smaller the pressure angle, the smaller the backlash when the gears are slightly separated. This should have been included as one of the advantages of the present system for such uses as change gears, printing-press work, etc.

I do not wish to be put in the position of discounting the complexity of the problem of interchangeable gearing. This question is indeed one of some difficulty. I do feel, however, that a new solution may be safely sought, through the ability and experience at the command of this society. The fact that the Brown & Sharpe standard gives excellent results for a wide field of work, even when the whole range from 12 teeth to the rack is covered by a set of 8, or at the most, 15 cutters, would indicate that the refinements hinted at are more imaginary than real; and the fact that two very different systems of interchangeable gearing (those mentioned by Messrs. Lewis and Hunt) have been tried out by exacting and competent engineers over a long period of years and over a wide range of application, to the entire satisfaction of the users, would indicate that departures from the old form can be made without fear of disastrous results. Furthermore, there is no practical engineering problem which cannot be solved by the combined application of technical training, perseverance and common sense.

Mr. Fellows (paragraph 1) makes the criticism that a longer theoretical action would have been obtained if the 12-tooth pinion had been considered as having the involute extend out to the points of the teeth, and if the flanks of the mating teeth had been undercut, when necessary, to allow this. It is true that more action might be obtained by a system so designed; this action would be truly involute in large gears, but in the case of small pinions it would amount, practically, to a rocking of the face of the tooth about the base of the involute on the mating tooth. This action is purely fortuitous, and is not susceptible of analysis. Besides, it undercuts the flanks of small pinions, leaving a distinct shoulder at the base line. This shoulder does not appear in teeth shaped by standard-formed cutters, where the involute merges smoothly into what appears (on the 12-tooth pinion) to be practically a radial flank. Thus no escape is left from the conclusion that teeth shaped by standard-formed cutters depart at their points very materially from the true involute form. On the other hand, if my memory

serves me, a 12-tooth pinion generated by Mr. Fellows' process shows a distinct shoulder at the base circle, so it is very likely that the involute in that case extends nearly or quite to the points of the teeth.

Professor Furman calls attention to the fact that the cycloidal system avoids all the corrections and modifications necessary with the involute system; and he suggests that its claims be considered in place of the involute for use in a standard system. It is true that the cycloidal form shows a marked advantage from the standpoint of pure kinematics; but, as Mr. Miller has pointed out, natural evolution, in free competition with the involute form, has resulted in the practical elimination of the cycloidal system. One of the disadvantages of the latter is the difficulty of obtaining sufficient side clearance for formed cutters; another is the difficulty of

large as it can be, and still be safe from interference with a sharp-cornered rack tooth.

His suggestion in paragraph 6 that much better results can be obtained by departing from the regulation proportions, is true. I have given much study to this matter. Many cases are found where the added expense of special cutters is warranted. This use of special gearing is becoming more common than many designers realize, especially in such work as printing presses, metal planers, etc., where the best possible results are required. I wish to make the suggestion that all such special gearing be stamped with some recognized symbol to show that it is special. This would avoid costly errors later, when the inevitable repairs have to be made, since it is often impossible to tell by inspection, or by any ordinary means of measurement, whether or not a gear is of

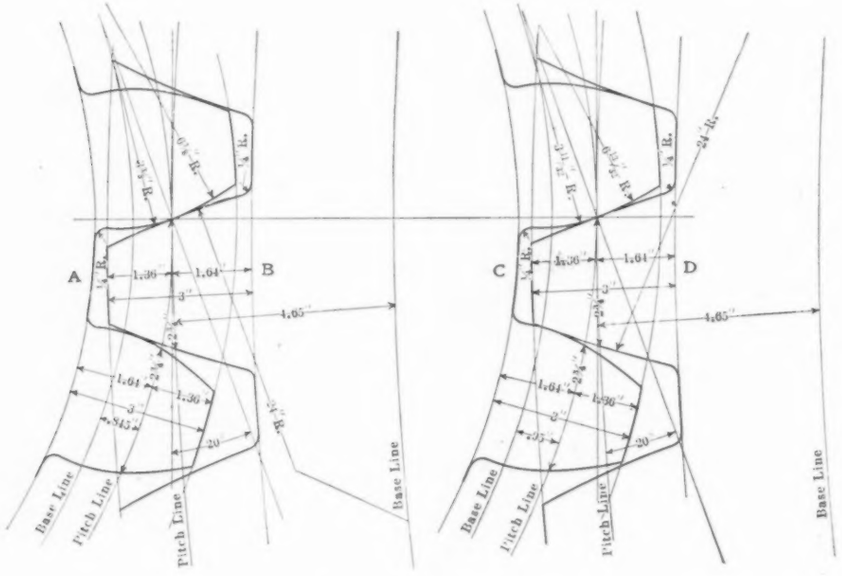


FIG. 8. SPECIAL 20-DEG. TEETH

Pinion *A*, 16 teeth; pitch, 5½ inches; face, 18 inches; pitch diameter, 28 inches; radius base circle, 13.155 inches. Gear *B*, 88 teeth; pitch, 5½ inches; face, 18 inches, pitch diameter, 154 inches; radius base circle, 72.35 inches. Pinion *C*, 18 teeth; pitch, 5½ inches; face, 18 inches; pitch diameter, 31½ inches; radius base circle, 14.8 inches. Gear *D*, 88 teeth; pitch, 5½ inches; face, 18 inches; pitch diameter, 154 inches; radius base circle, 72.35 inches.

generating the curves as compared with the involute. For a general-purpose system of interchangeable gears, the cycloidal form is "out of the running."

Professor Furman, in paragraph 2, asks why I used the method described for generating the flanks and fillets of the teeth used in finding the strength factors. The most convenient way to study a standard system theoretically is to consider it as generated from a standard rack. This has its counterpart in actual practice in the action of the gear-hobbing machine. To obtain, then, a rationally practical form of tooth, it was considered to be generated from a hob. In making a hob, I would round the corners as described, to obviate a rough or stepped generation of the fillet; this procedure also makes the fillet as standard form. All this is aside from the question at issue, however.

Mr. Logue's discussion expresses the viewpoint of the engineer who has specialized in the design and manufacture of gearing, and very logically and forcibly describes present conditions in the field of heavy work. These conditions now appear to be well on the road to remedy, thanks to the action of the members and the council of this society.

The production of all kinds of rails in the United States in 1908 amounted to 1,921,611 tons, against 3,633,654 tons in 1907, a decrease of 1,712,043 tons. The falling off in Pennsylvania amounted to 637,745 tons.

Skew Bevel Gears

By J. A. Utts

This pair of gears, Fig. 1, is the problem that the writer was "up against" a few months ago, and the way the job was done is the burden of this paper.

The axes of the gears are at right angles, but in planes a distance of 2.25 inches from each other (see Fig. 2). A little study of this sketch will show that the line *A B* corresponds to the line of contact of the pitch cones of a pair of bevel gears, if continued to the point of intersection, also that the line *A B* must be at 45 degrees angle as that of a pair of miter gears; also by referring again to Fig. 1, it will be seen that the ends of the teeth have the same appearance as do the teeth on a common bevel gear, or in other words, the teeth must not be canted, but at every point throughout the length of the tooth, a line, drawn through the vertical center of the tooth, must pass through the axis of gear.

Any mechanic who has watched a gear shaper at work will know that if the blank can be rotated while the tool is cutting, a spiral tooth will be produced, but in this case, the spiral not being constant, the rotating of the blank must be in the proper ratio at every point along the path of the tool. As the job was done on a Gleason gear shaper, it is now fully presented to the reader.

The rotating is accomplished by an arm (secured to the spindle) actuated by a cam slot (Fig. 3); the cam piece is secured to the lever (Fig. 4), which is moved in unison with the tool by the arm *A* (Fig. 5) secured to the tool head. Note the piece *B* (Fig. 5) set upright in the arm; this is a close working fit in the arm and the circular surfaces (see *B*, Fig. 3) are concentric with the common center of the machine, as is also the circular slot in the end of the lever. These circular surfaces are necessary to allow universal movement of the tool-head arm, and at the same time impart as little motion to the lever as possible.

Right here I can hear someone say that there are false and inaccurate motions, but please be patient.

The master form (see Fig. 6) was finished by setting the turning tool 1.125 inches above the center and feeding with the compound rest set at 45 degrees; this produced the curved surface shown. On taking the finishing cut it was necessary to revolve the work in opposite directions in order that a cutting edge would be presented. The line *A B* was then drawn with the point of a scratcher set in same position as the tool and drawn across the form with the compound rest. This line corresponds to the line of contact on the pitch cones of a pair of miter gears.

The spindle is in two parts; the outer

or quill has a plate with index pin keyed to one end and the rotating arm (Fig. 3) keyed fast to the other end. The inner spindle has an index plate keyed to one end and arbors for holding blanks at the other end; the two parts are rotated as one when the index pin is inserted and the inner can be revolved within the outer for spacing the blank when the index pin is withdrawn. The arbors are so made that both gears are given the proper "placing distance" without moving the spindle head, thereby maintaining the rotating arm in the proper location in relation to the cam slot.

To generate the cam slot a short temporary arm was substituted for the arm (Fig. 3). The master form was held on concentric with the arm. The tool head was then moved forward a fraction of an inch, the spindle was revolved until the line *A B* again coincided with the scratcher point, when another circle was scribed on the cam piece. This was repeated until a series of circles were scribed, completing the laying out of the cam slot. The cam piece was then taken off; the slot was roughed out and then again secured in place; the cylinder was replaced by a shell reamer and the operation of laying out was repeated, except that the reamer was used to cut down through the slot at every stop, thus making a series of finished points in the cam slot. The slot was then finished with a file; it was a simple operation, as it consisted simply of constant takeup in case of wear and also keep the working side of all parts in close contact when the tool was on the cutting stroke.

It was found that the common 14½-degree involute tooth would not clear, but by making the angle 20 degrees the teeth cleared nicely. No fitting with a file was done; the teeth were machined to a finish.

These gears are required to work together smoothly without any lost motion and also to be interchangeable. These requirements were fulfilled. Of course, there are some slight inaccuracies in the teeth, but as the best authority I have thus far been able to find says that the correct shape of tooth on this form of

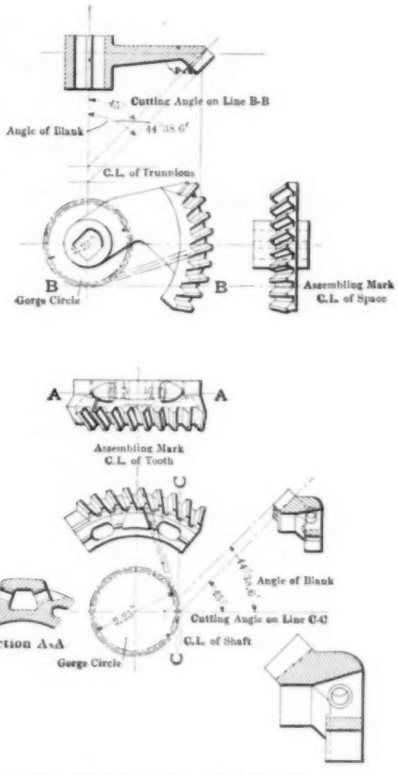


FIG. 1. DETAILS OF SKEW-BEVEL GEARS

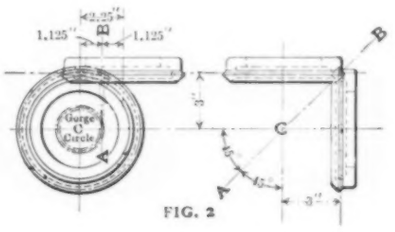


FIG. 2

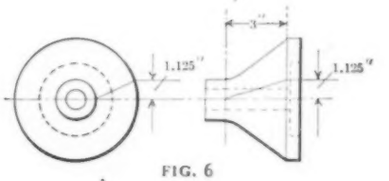
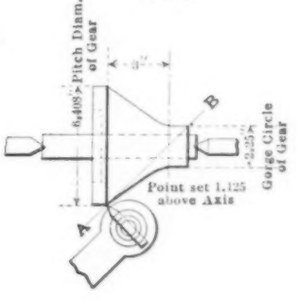


FIG. 6



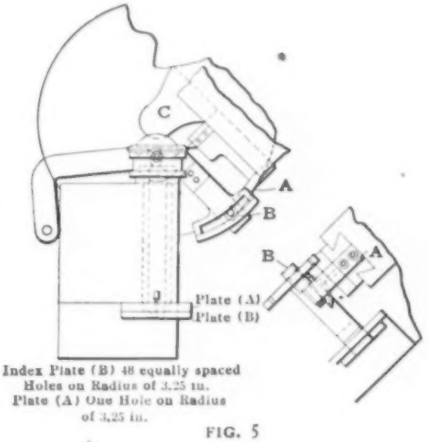


FIG. 5

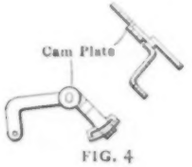


FIG. 4

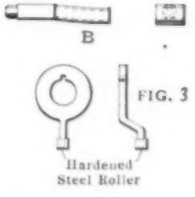


FIG. 3

SPECIAL ATTACHMENT DESIGNED TO PLANE SKEW-BEVEL GEARS

the arbor as a gear blank would be for machining, a scratcher was held in the tool holder with the point in the same location as the cutting point of a tool; the machine was then fed up until the point just touched the form; the form was then revolved on the arbor until the line *A B* was brought to coincide with the scratcher point and then clamped fast to the arbor. The cam piece (see Fig. 4) was secured to the lever; a circle was drawn on it by a hardened cylinder of the same outside diameter as the roller on the arm (Fig. 3) but cut away at an angle to its axis so as to make a sharp point at its circumference; as the cylinder was free to slide and turn on the arm, it was a simple matter to scribe a circle on the cam piece, taking off the small points left between the reamer cuts. It will be seen that the cam slot thus generated compensates or absorbs all false or inaccurate motions of the lever.

Now with the cam piece and rotating arm in place and a blank on the arbor, the cutting of the teeth was proceeded with, the same as if cutting a common bevel gear (see assembled view, Fig. 5).

A detail worthy of note is the floating piece that forms one side of the cam slot and another, not shown, that forms one side of the circular slot in the lever. These pieces are free to slide on guide pins and are held against roller in the cam slot and against the piece *B* (Fig. 5) in the lever by springs, the object being to provide a gear can only be approximated in practice, I believe I have produced a practically perfect gear of its kind.

One would scarcely expect that the United States would be a large importer of copper products, as she produces more than one half of the copper of the world; but a report issued by the Bureau of Statistics of the Department of Commerce and Labor shows that there were imported into the United States in 1908 practically 50 million pounds of copper ore, 145 million pounds of copper in pigs, bars, ingots, etc., and one hundred thousand dollars' worth of other manufactures of copper.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Power Socket Wrench—Reaming and Boring Holes in Line

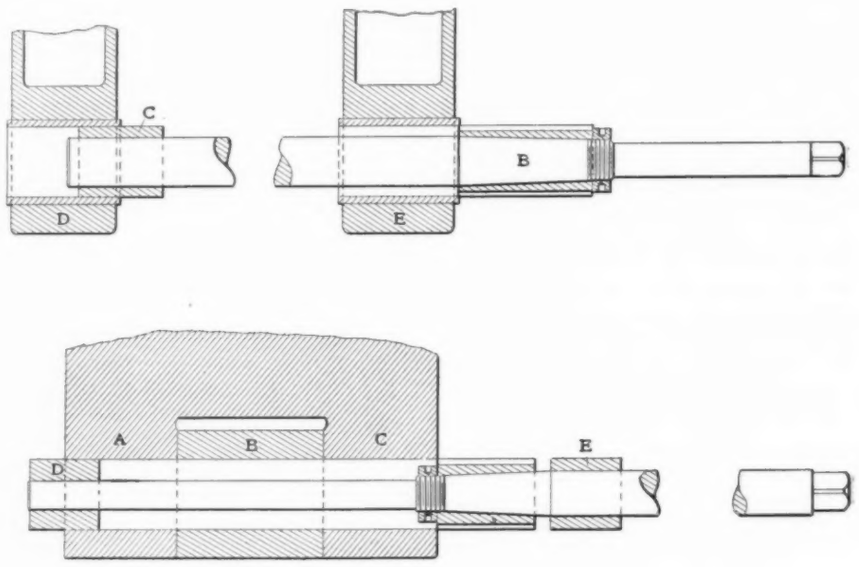
The following devices, which have been used at the works of the Fellows Gear Shaper Company, Springfield, Vt., may be of interest to the readers of the AMERICAN MACHINIST:

Fig. 1 is a sectional view of a power socket wrench designed to rapidly screw hexagon bolts and nuts into place. The taper shank of the spindle *A* fits in the drill-press socket. *C* and *D* have a clutch milled on the end of each, so that *C*, acting as a driver, engages *D* and rotates *E*, which has a recess into which the hexagon head of the bolt is received. This recess is correctly formed by broaching. The office of piece *B* is to keep *D* and *E* on the spindle when no work is being done. When a number of parts are to be screwed into place, the piece carrying the bolts is placed on the drill-press platen. The operator then feeds the spindle down by hand, and *E*, engaging a bolt, rapidly screws it into position. When the head of the bolt comes up against the casting, the spindle moves upward by reason of the angle clutch on *C* and *D*. Of course, the operator is applying some pressure when the bolt head strikes the casting, but he automatically releases the handle when he feels the slight shock. The bolts are thus screwed tightly into place, and the work is very rapidly done.

It is found that reaming holes in line when the bearings are located, as in Fig. 2, is very easily accomplished by the method shown. The bushing *C* tapered slightly on the outside, is placed as shown, and guides the reamer bar *B*. When the hole at *E* has been reamed, the bushing is placed at *E*, and the hole at *D* is reamed. The holes then line very nicely.

At Fig. 3, *B* is a moving part which fits between *A* and *C*. The pivot upon which *B* moves takes a bearing in *A* and *C*, and a straight, smooth hole is necessary. When the reamer has entered the hole far enough the bushing *E* is pushed into the hole and together with *D* guides the bar. When near the end of its course, the reamer pushes *D* from the hole and completes the hole, guided by the bushing and part of the hole already reamed.

Referring to Fig. 4, it is necessary to have the hole at *A* in the support *C* accurately in line with the center of the spindle *B*. The taper bushing *B* is a nice fit in the spindle, and the boring bar *F* is



FIGS. 2 AND 3. REAMING IN LINE

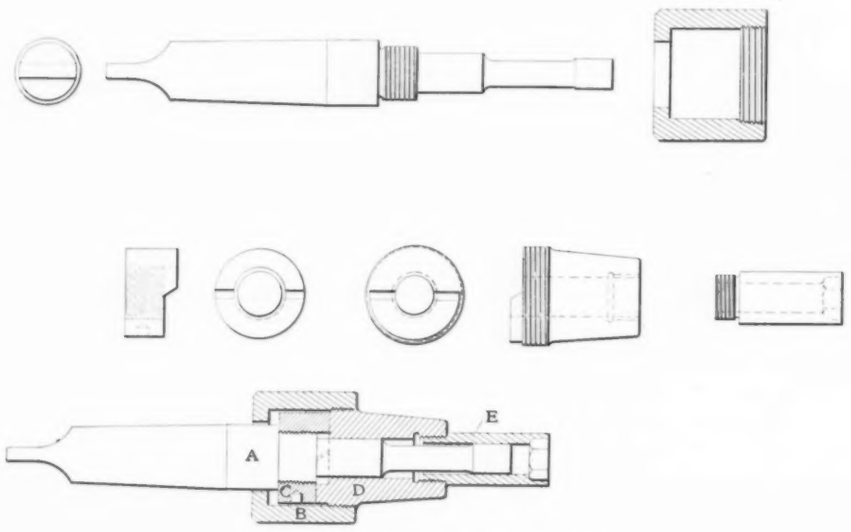


FIG. 1. POWER-DRIVEN SOCKET WRENCH

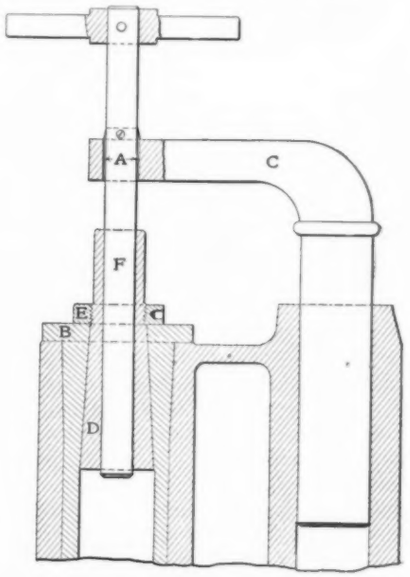


FIG. 4. BORING IN LINE

guided by this bushing. The hole to be bored is drilled to within 1/64 inch of the size, and when the support has been clamped, the hole is bored out by hand. Two cuts are taken, and the tool scrapes only a few thousandths on the last cut. Boring this hole has been attempted, using several different methods of power drive, but the one shown proved most satisfactory.

Springfield, Vt. E. W. M.

Two Compressed Air Rams

I inclose a sketch, Fig. 1, of an air ram for use in the boiler repair shop. An arrangement similar to this is in use in one of the large railroad locomotive repair shops, and it is claimed that with its use one man does a job (taking out a mud ring) in one day and a half, which often took two men as much as eight days.

The arrangement is plainly shown in the sketch. It consists of a hammer fastened to a piston which is connected to a smaller piston by a rod. The whole is contained in a piece of lap-welded iron pipe 5 feet 6 inches in length by 5 inches inside diameter.

It is suspended near the boiler from which the mud ring is to be removed, a chisel-shaped tool is used to cut the heads from the rivets. Then a punch-shaped tool is used to drive the rivets out. This ram is operated by compressed air, and the blow is automatically continuous.

By referring to the sketch it will be seen that by the use of hand wheel *A* the length of stroke of the *D* slide valve will be limited, and thus by throttling the air as it enters the small cylinder the speed of the return stroke will be reduced. This will result in reducing the number of blows delivered per minute.

By adjusting the hand wheel *B* the speed of the driving stroke, and the force of the blow may be reduced or varied.

The *D* slide valve is operated by a 3-inch air cylinder which becomes connected to the portion of the cylinder containing air under pressure after the respective piston passes a certain point in its stroke. These connections are shown and marked ½-inch pipe.

Fig. 2 is another form of air ram to be used as a substitute for a sledge hammer where there is not room enough to swing a sledge. I have found this arrangement very useful for driving bolts in and out of locomotive frames. As indicated in sketch, the ram is operated by compressed air, controlled by a hand valve.

This little arrangement is not expensive to make, and is very often needed wherever compressed-air connections are available, and especially in repair work.

Cortlandt, N. Y. W. S. DRUMMOND.

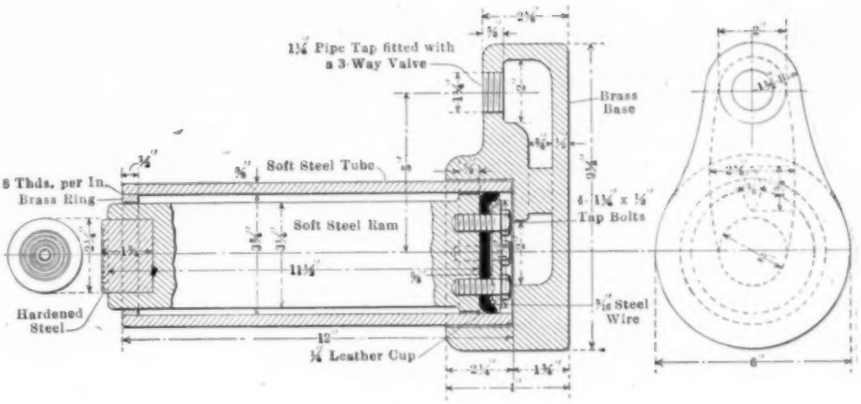
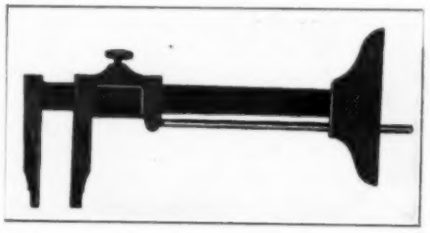

1¼" Pipe Tap fitted with a 3-Way Valve
Brass Base
Soft Steel Tube
8 Thds. per In. Brass Ring
Soft Steel Ram
4 - 1¼" x ⅜" Tap Bolts
Hardened Steel
5/16" Steel Wire
¼" Leather Cup

FIG. 2. SMALL AIR RAM FOR CLOSE QUARTERS

The Caliper Square as a Depth Gage

A friend of mine has added a depth gage to his caliper square that will be



CALIPER SQUARE AS A DEPTH GAGE

readily appreciated by toolmakers employed on certain kinds of work. The cut needs no explanation, except that the depth gage registers the same as the caliper jaws.

Decatur, Ill. ETHAN VIALL.

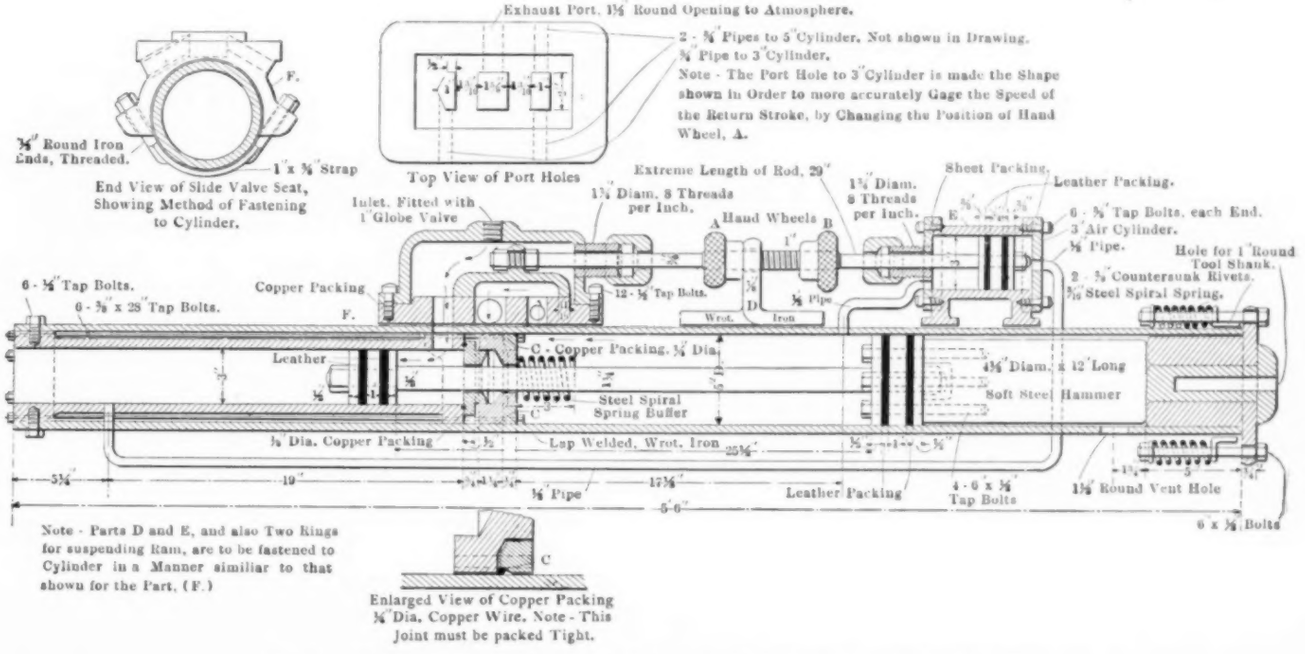

Exhaust Port, 1½" Round Opening to Atmosphere.
2 - ¾" Pipes to 5" Cylinder, Not shown in Drawing.
¾" Pipe to 3" Cylinder.
Note - The Port Hole to 3" Cylinder is made the Shape shown in Order to more accurately Gage the Speed of the Return Stroke, by Changing the Position of Hand Wheel, A.
⅜" Round Iron Ends, Threaded.
1" x ⅜" Strap
End View of Slide Valve Seat, Showing Method of Fastening to Cylinder.
Top View of Port Holes
Extreme Length of Rod, 29"
1¾" Diam. 8 Threads per Inch.
Sheet Packing.
Leather Packing.
Inlet, Fitted with 1" Globe Valve
Hand Wheels
6 - ⅝" Tap Bolts, each End.
3" Air Cylinder.
⅛" Pipe.
Hole for 1" Round Tool Shank.
2 - ⅜" Countersunk Rivets.
5/16" Steel Spiral Spring.
6 - ½" Tap Bolts.
6 - ⅜" x 2⅝" Tap Bolts.
Copper Packing
12 - ½" Tap Bolts.
Leather
C - Copper Packing, ¾" Dia.
4¾" Diam. x 12" Long Soft Steel Hammer
Steel Spiral Spring Buffer
⅛" Dia. Copper Packing
Lap Welded, Wrot. Iron
¼" Pipe
Leather Packing
4 - 6 x ⅜" Tap Bolts
1½" Round Vent Hole
6 x ⅜" Bolts
Note - Parts D and E, and also Two Rings for suspending Ram, are to be fastened to Cylinder in a Manner similiar to that shown for the Part, (F.)
Enlarged View of Copper Packing ¼" Dia. Copper Wire. Note - This Joint must be packed Tight.

FIG. 1. AIR RAM FOR CUTTING HEADS FROM, AND DRIVING OUT MUD-RING RIVETS

Sammy's Shop—The Case of Miers

"I want work, mister; give me a job." Sammy turned and looked at the speaker, and for a short time he thought instead of saying anything.

This was in the days when the shop was a very small one and each employee in it had been selected with care, and by Sammy personally. While every man who had been hired had not turned out to be first class, the average had been high and when it came to the boys Sammy was proud of them. He saw among them material out of which would come foremen for not only his own needs but for those of his fellow shop owners who had not been so thoughtful in selecting good material.

This boy who had asked for a job had applied for it a number of times. Sammy had never given him any encouragement for he was not interested in, or looking for that type of a boy. He made Sammy think of the oxen that he had seen at work in the lumber woods; strong, patient and plodding, but without any snap and originality.

As Sammy stood looking at the boy he had been thinking. Before this every boy had been taken on with the idea that some day he would get to be a machinist, and the thought came to him that perhaps it would be a good thing if he had one boy around who was not working with that idea.

"What kind of work do you want?" he asked.

"I want any kind of work you have," the boy replied.

"Did you ever work any?" was the next question.

"I worked in a ditch, digging a sewer, and now the work is done and I want a job. I worked as long at it as they had anybody."

One of the things that had been troubling Sammy was the fact that he had some work around the place that smart and ambitious men and boys did not like to do and this kind of work was either overlooked or else it was very poorly done. A look around always showed that the corners were not properly swept out. The general workbench was seldom brushed off and put in order, while he was positively ashamed to have an outsider visit the toilet room. The bolt cutter was used by every man who had need of it, and it took a direct command to get any one to clean it up, and even when that was done it only got "a lick and a promise," while the pipe machine was a good mate for it. Yes! It looked as though the shop needed one workman at least who was not ambitious.

"If I gave you a job how long would you stay and do as you are told to do?"

"I will stay as long as you have work for me, and if you show me what you want me to do I will do that."

Sammy did not fail to note the curious way this answer was worded. Later he found that the boy had expressed the fact. The way to have him know what was wanted was to show him, and then the way he would do it would be the way he had been shown. If he did not do it right it was because the showing had not been done with enough persistence and thoroughness.

"I have a job for you. When can you come to work?"

"I am ready now." And the boy took off his coat.

The action showed a willingness that did not displease Sammy. "All right. Come with me—Say! What is your name?"

"Miers." There was no attempt to add anything to it, and that is the name he continued to be known by.

The first time this boy had asked for work Sammy had turned him away without the least hesitation. The boy was big and strong and had all the appearances of being thick headed and Sammy wanted, for regular use, boys who had brains. He soon found that he was right in his opinion that Miers was thick headed. It was not any trouble to get him to do the sweeping and cleaning up in good shape but he was a persistent worker and had often some spare time. Sammy started to teach him how to run the bolt cutter. Often bolts got bruised, and if Miers could put them in shape in his spare time it would be a saving. Sammy interlaced the showing, at first, with verbal explanations, just as he had been in the habit of doing when showing the other boys, but he soon found that the less talking he did with Miers the better. Showing was what he wanted, and very careful showing without a missing link. It took an amount of showing that was discouraging, for Sammy had boys who "caught on quickly," but there was one redeeming feature; that same thick head that it took hard work to get an idea through had a way of keeping the idea in after it was once safe inside.

When you get several boys together in a shop there is generally more or less "horse play," and the new boy generally has a lot of it to stand.

Several times Sammy saw little things that made him understand that the boys were trying to have fun with Miers. If Miers understood it he did not make any complaint. Sammy kept alert so that it would not go too far. Generally such things were carried along until a boy was induced to do something that would make him the laughing stock of the whole shop, to the delight of the other boys who would tell of it for years afterward.

These efforts did not last in the case of Miers, and Sammy rather wondered at it but did not know the reason until some time afterward when one of the men told him why it was.

Miers was so slow that many of the ancient shop jokes lost their force when applied to him, and the boys tried to make up for it in devising nicknames for him, and in scattering dirt that he had swept up, etc. One boy was particularly active in this. One day Miers remarked to this boy in his slow even way of speaking (one of the boys said that Miers pulled his words out just as though he was pulling tacks out of a board with a pair of pliers), "I am working. If you have to bother me do it at dinner time or in the evening."

The boy thought that it would be a good idea to do so and tried it. He gave the men a display of all the nicknames that had been invented for Miers. Miers seemed so utterly indifferent to it that he wound up his part of the performance by taking hold of Miers and hitting him a slap. Suddenly Miers seemed to wake up, and for his part gave an exhibition of what a slow boy can do in the way of inflicting corporal chastisement when he gets under way. A chum of the first boy undertook to help his friend but speedily wished that he had been more discreet, and both boys yelled for quarter. Miers stopped, and as soon as he had taken a good breath remarked, "Maybe someone else wants some fun?"

If anyone else did he was too modest to let it be known. The first boy kept out of Sammy's sight as much as he could for several days so as to let his appearance get back to normal, and all of them seemed to have lost all interest in trying to improve Miers in the old fashioned boy way.

As the months rolled on Miers learned to do everything on the bolt cutter that could be done there and he also ran the pipe machine. He never made any record time but if bad work turned up and was traced back to either of these machines it was always found that Miers had not done it.

A laborer had been put on the cleaning-up job and in spare time Miers did some work on the drill press. He got a start on the lathe because of a lot of rough work that the boys were always sulky if they were put at and a machinist would not do because it was a reflection on his skill.

When times got slack and men had to be laid off Miers was kept on because he knew how to do a lot of things that most fellows do not like to do and he never made any fuss about doing them. If he had some time on his hands and the boss was not around he would sweep up and wheel out chips rather than be idle.

With a reduced force, and the shop doing jobbing work, Miers got some experience on most of the machines in the shop, and it surprised Sammy to see how he broadened out. Whatever lack there was of natural quickness was largely com-

pensated for by tenacity of purpose, and what he lacked in speed he made up keeping always going.

Times improved and the business grew. New men had to be taken on.

A line of manufacturing was developed and someone had to train the new hands into the ways of the shop. Sammy realized, one day, that Miers was the most competent man he had when it came to shop work.

He is now a working foreman.

Oil City, Penn. W. OSBORNE.

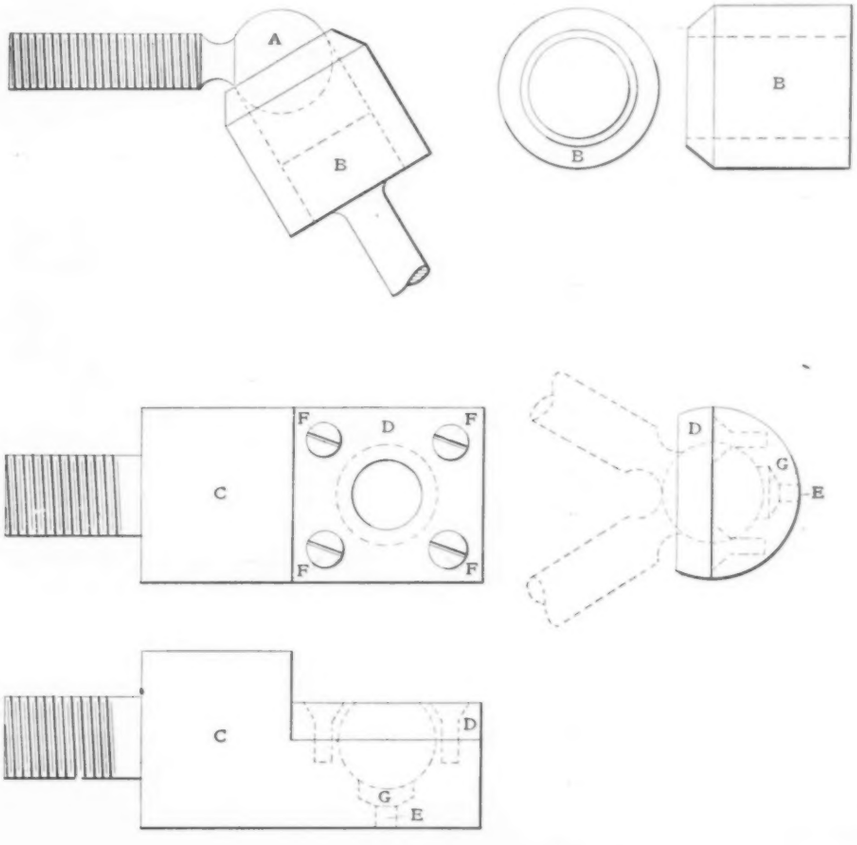
Making Some Special Ball and Socket Joints

On a certain machine which we were building there was a connecting rod with a ball at each end working in a socket. A canvass of several machine-screw concerns resulted in our placing an order for the 200 ball ends *A* needed for the 100 connecting rods. The concern agreed to give us the balls within 0.002 inch of size. As this part of the machine was necessarily exact we ordered the balls to be made 0.005 inch large so that we could finish them to size ourselves. The finishing was done by hand in a speed lathe with the tool *B* made of a piece of tool steel hardened, tempered and ground inside ¾ inch diameter. The face of the tool for about 1/16 inch all around the hole was ground square with the bore. The chamfer was to permit the tool to be oscillated back and forth on the work. One of the pieces was gripped in a self-centering drill chuck and the tool forced against the ball, the work being well lubricated with lard oil. The reduction of the 0.005 inch was very quickly accomplished and the finish all that could be desired. As soon as the ball was finished all over to size it slipped inside the tool, past the cutting edge. No gaging was necessary as the tool could not cut below size and could not help cutting while the work was oversize.

After the balls were all finished the seats for them were the next consideration. The seat in one end was in a machine-steel shaft *C* and in the other end in a small cast-iron piece. As the method of finishing both seats was the same I will show how they were finished in the machine-steel shaft only. The shafts were made from cold-rolled stock on a turret lathe; they were then milled across one end and the caps *D* fitted, using simple jigs so as to get them all alike. The oil hole *E* was then drilled through cap and shaft. After removing the caps a flat drill with a small tit fitting the oil hole was ground to make a hemispherical hole leaving 1/64 inch all around for finish. A tool-steel ball was then carefully annealed, drilled and tapped ⅜ inch to make the cutter. Teeth were filed on the lower half of the ball and a threaded shank fitted to the hole in the top. After hardening the ball tool was run down within about 0.002 inch of depth. The caps *C* were treated in exactly the same manner, leaving 0.002 inch for the final finish.

The finishing tool was also made from a steel ball but had teeth both top and bottom. The shank of the tool was slipped through the hole in the cap and the cap fitted to the shaft with a piece of tissue paper between it and the shaft. While the ball tool was rotated the screws *F* were tightened, the shaft *C* being held in the operator's hand. When the cap was tight down on the paper the ball tool would not cut any more. After assembling and running the machines for a few hours the tissue paper could be taken out and the cap and shaft were screwed tight metal to metal, making a snug yet free ball-and-socket joint. Before entering the flat ball drill a twist drill was run down leaving the recess *G*.

New York. E. A. DIXIE.

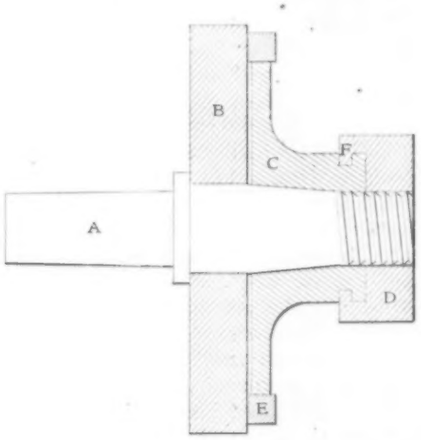


MAKING SOME SPECIAL BALL AND SOCKET JOINTS

Facing Piston Rings

The line cut shows a simple device I made for facing cast-iron piston rings to thickness. *A* is a machine-steel piece, which fits the center hole in the line spindle. *B* is a face plate which is fitted snug on *B* and faced in position for the ring *E* to abut against. *C* is an expanding washer which fits on the taper part of *A*. It is slotted on one side so that it will expand when forced up the taper by the nut *D*.

The nut *D* is made in halves, which are fastened together by two screws or bolts not shown, so that the flange *F* can work in the groove in *C* and draw the washer *C* back to release the piston ring *E*. I have made these expanding mandrels for the various sizes of rings we make and find them very satisfactory.



FACING PISTON RINGS

NIC. W. TRAUTER.

Red Wing, Minn.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Metal Cutting Tools without Clearance

I have read with great interest the paper on "Metal-cutting Tools Without Clearance," by James Hartness, on page 807, Volume 31, Part 2, and particularly that portion which deals with cutting tools of a much more acute angle than those in general use, as it bears out the results obtained in the works with which I am connected. It should be stated, at once, that the facts relating to "no clearance," and the automatic swiveling of the tool are entirely novel to us, but acute-angled tools of 45 to 50 degrees have been in use in the machine shops here since 1901, to the almost total exclusion of the old form, on engine lathes, boring machines, planers, etc.

The change came about for two reasons. As all the machine tools are electrically driven—many of them by individual motors—it was an easy matter to make tests of the power absorbed when using tools of various angles. It was found on experimenting with a boring machine for machining steel-magnet castings, that the best results were obtained with these sharp-angled tools; that is, the work produced was better finished, the tools lasted well, and the power required was less.

It then occurred to me that the tool steel might be obtained of a triangular section, giving approximately the angle decided upon, without any forging. Inquiries were made, and several Sheffield firms undertook to roll the desired section. Tool steel was then obtained in this form; no forging had to be done subsequently; it was merely necessary to cut the bar up into the required lengths, and grind the ends—one end forming a right-hand cutting tool, and the other end a left-hand tool. As the leading side of the tool stands at 90 degrees vertically to the slide rest, a small amount of clearance is always ground, and in this respect it differs from Mr. Hartness' plan. The half-tone shows a tool.

The same tools are used throughout the shops for turning, boring and planing work on wrought iron, mild steel up to 45 carbon, steel castings, and cast iron, and have proved most satisfactory. In 1903, high-speed air-hardening steel was obtained of the same section and this has replaced the carbon steel formerly used. Two sections are in general use, the 1-inch triangle and 1½-inch triangle; or, perhaps to speak correctly, one should call it a trapezoidal section. Cuttings are obtained exactly as shown in the illustrations on page 808 in the form of long-volute spirals.

The same conclusions have been reached as stated in the paper under discussion; viz., (a) The cutting stress is reduced, thereby increasing the output of machines which have been limited by lack of pulling power. (b) The reduction of cutting stress has increased the accuracy of the work. (c) The reduction of cutting stress also increases the output where it has been limited by the slenderness of the work. (d) The chips come off at a much lower temperature under similar speed and feed, and are more easily controlled.

I am not prepared to say that tools with these acute angles are suitable for very heavy classes of work, such as marine and gun work, but for the particular class of work undertaken in the shops where they are now being used, they are much superior in all points to the old comparatively blunt tools, used under the same conditions.

GEORGE RALPH.

Newcastle-on-Tyne, England.

Locating the Intermediate Center

The author of the article on "Locating the Intermediate Center," at page 931, Volume 31, Part 2, seems to distinguish several cases in an exceedingly simple problem, which is completely covered in all its relations by the first case shown, which is also the most exact way of attacking such a problem. The fact that the centers B and C do not come in a horizontal or vertical line should not affect the problem in the least, unless we are restricted in selecting our coördinate axes, which would hardly, if ever, apply to this problem.

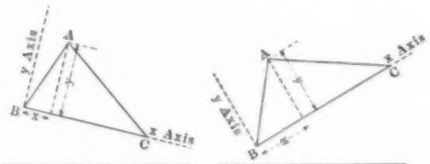


FIG. 2 FIG. 3

DIAGRAMS ILLUSTRATING METHOD OF LOCATING INTERMEDIATE CENTER

Such a problem may always be solved by the first method if the point B is selected as the origin of coördinates, the line BC as the axis of abscissas and a line through B, perpendicular to BC as the axis of ordinates. Thus Figs. 2 and 3 of the article quoted would appear as shown, and the calculations with respect to the new axes would be made as in the simple method first exhibited in the original article. As will be seen from the figures, each of the cases is exactly the same in solution as the first. Of course, the values of x and y so determined must be measured parallel to the axes chosen.

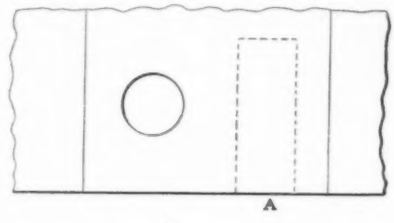
This method which is theoretically and practically exact (not only the personal accuracy of the worker being the determining factor in attaining the correct result) will do away with any assumption as to a permissible variation in the location of the point C, the necessity for which I do not quite understand.

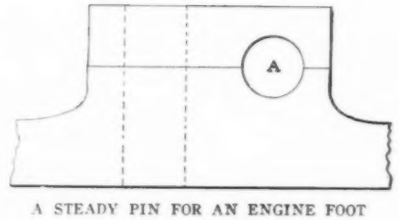
WILLIAM L. BENITZ.

Notre Dame, Ind.

Things That Are Usually Wrong—Fitting Steady Pins in Engine Cylinder Feet

Referring to the article on the above subject on page 70, it seems to me that there is more to this than seems to be brought out by the article. As the size of the cylinder is not given, we can only assume from the terms "heavy engine builders" and "low-speed horizontal compound" that the cylinders were large. Now cylinders expand in all directions; suppose, for instance, we have a cylinder 3 feet long from center to center of the feet and 3 feet wide from center to center of the feet, it is reasonable to suppose





A STEADY PIN FOR AN ENGINE FOOT

that it will expand under steam as much one way as it will the other. With the round steady pins, as shown in the cut, there would be no allowance for lateral expansion, but with the rectangular key there would be. What seems to me just as good a way and a lot easier than fitting a square key would be to drill a hole as at *A*, ream it, and fit a round pin to it.

One could get the same shearing area as the square key with the same work as fitting the round pin, the only difference being that the chips would not drop out as readily.

E. A. DIXIE.

An Automatic Screw Machine Job

At page 66 appears a discussion on my article published under the above title at page 714, Vol. 31, Part 2. I was very much interested to read how Don Nevin would do the job. As I stated in my article, knowing the requirements we proceed to figure out what is required for tools. If the piece under discussion was for a lawn mower, I would agree with Don Nevin that 600 would be a fair day's output and could do better. But as it is part of an instrument for indicating speeds it is different. As I mentioned, the hole must run true with the flanges and body, and no limit is allowed; meaning that the hole must be 0.249 inch and have no taper. The sides must be straight and smooth. I am confident from past experience, that if I used the forming tool shown in his sketch *A*, the sides of the work would not be straight nor smooth. He shows one degree clearance on the sides of the tool. At page 775, Vol. 31, Part 1, I gave my experience with tools having such clearance. He advises facing off while centering, but as explained at page 714 I fed out ⅛ inch more stock than required in order to use a rest on it while forming. I understand the use of a plug support, but it would wear the hole at least 0.002 inch and supposing it did wear while forming, would the body or flanges be straight? I doubt it as the forming tool would certainly press the stock against the plug. The allowance referred to of 0.003 on the body is for diameter. This must, however, be true so this method appears to involve much of a risk. I mentioned that I got a job to be proud of. When you want quality go a little easy on quantity and always consider extra operations and repairs. The part we have discussed has the hole recessed, leaving ⅛ inch at each end for bearing. I take no chances of spoiling the ends from chips getting around the recessing tool, so make a second operation. Of course, there are many different ways to do the job and we all have something to learn.

While ordering automatics with tools and cams for several pieces, I had a visit from the man that was to design the tools. He said I could help him greatly by telling him what the parts were used for and how close they had to be made. I took it for granted that, if close, he would figure on quality and if not close, on quantity.

W. M. MCKENZIE.

New Rochelle, N. Y.

Osborne's Wonder Clock

The "Wonder Clock" described by Mr. Osborne, on page 60, was also on exhibition in this city for several weeks, and at noon hours and on Sundays the mechanics and others both old and young, looked it over and discussed it.

The older mechanics, whom Mr. Osborne so cheerfully assumes to be able to understand it, were as dense on the subject as the younger men, although being old mechanics they did not talk much and looked wise.

A little point not noted in the description is that the counterbalances were apparently hollow with nicely fitted covers from which ran extra heavy ribs.

After being on exhibition for some days the following explanation was given:

"There are no pendulous oscillations cognizable, but the elongated indicators of aluminum construction perambulate a circumscribed radius with a circumferential activity, thereby registering accurately the subdivisions of its circumference. The energizing impulse necessary to accomplish the resultant activity is not sufficiently accelerated to destroy the molecular cohesion of its atomic constituents. Its synchronization is promulgated by the dissemination of actinic rays, and the nocturnal and diurnal deflections are equalized by contraction and expansion." It's easy when you understand it.

Following Mr. Osborne's example I am too modest to give my explanation, but "they do say" that by placing the ear close to either counterbalance you would hear sounds that resembled a clock mechanism in action.

Rochester, N. Y. RALPH W. DAVIS.

Glazing of Cast Iron under Water

On page 28 of Vol. 32, John Johnston tells of his experience with sawing cast iron under water with a hack saw and asks for the reason that the iron glazed. When cutting cast iron under water or any place where the saw will become wet, trouble will be had, caused by the clogging of the saw teeth with the paste formed by the mixture of iron dust and water. This clogging causes the teeth to slip and form a glazed surface. Better results can be had by using saws with coarse teeth and a wide offset. This offset will cut a wider slot and allow a free passage for the chips.

Aurora, Ill. JOHN B. SPERRY.

Graduations for the Tailstock

In the article under the above heading, by W. Loach, on page 859, the graduating of the setover of the tailstock of a lathe, in thousandths of an inch is advocated.

This would not be of any practical value, as the setting over of a tailstock can only be approximate at the best, as two pieces the same length will be turned a different taper, owing to the difference of the depth of their center holes, and for duplicate results, a regular taper attachment is necessary.

The method of applying an indicator needle to the tailstock, as shown, is also inaccurate, as the motion on the needle point is greater near the zero mark, and decreases as it recedes from it, in which case, to make the reading accurate, a differentially graduated arc would be needed.

As to rollers on the steady-rest jaws, this is also impractical, as the slightest inaccuracy of the rollers or their bearings would throw the work out of true, as it rotated. We had a steady rest fixed this way in the first shop I worked in, and one trial was enough for anyone who cared for accurate results. There are classes of work where a roller rest can be used to advantage, but for lathe work, the steady rest is best as it is.

Decatur, Ill. ETHAN VIALL.

A Simple Method of Chalking Tracing Cloth

I noticed the article on "Chalking Tracing Cloth," on page 388 by F. W. Harris, and also the "Simple Method," by "Blueprint," on page 863. I think I have a better method than either.

I took a box about 2 inches in diameter and 1½ inches deep (one that McGill's fasteners came in) and a cork a little smaller in diameter and a little thicker than the cover was deep. I covered the cork with three thicknesses of flannel and tacked it on the inside of the cover, making a pad.

Fill the box half full of chalk, turn over or give it a slight shake, take the cover off and rub the tracings with it (the pad on the inside of the cover). I have used this about eight years and would not be without it.

Springfield, Mass. G. V.

There is being erected at Great Falls, Mont., by a mining company what will be the world's largest stack upon its completion. Its total hight will be 506 feet; diameter at the top, 50 feet; diameter at base, 78 feet 6 inches; concrete foundation, 25 feet deep, 103 feet in diameter; weight, 34,000,000 pounds; inside volume, 1,336,000 cubic feet.

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The Anti-Japanese Agitation on the Pacific Coast

Throughout the discussion that has been running through the daily press relative to the proposed anti-Japanese legislation in California and other Pacific coast States, much has been said regarding the injury to trade interests which will certainly follow the passage of the proposed legislation. We doubt if our readers realize the fact that this shoe pinches them, in that this trade is largely in the products of the machine shop which today needs every avenue for its output that exists.

The following letter voices our own sentiments so well, while it gives figures with which we were not familiar, and its signature is one which cannot but command attention wherever it is seen, that we are led to publish it in this column:

In connection with the anti-Japanese legislation now before the California legislature, which has been widely discussed in the papers throughout the country during the past few weeks, and with which you are no doubt familiar, I have had my attention directed by several prominent Japanese residents in this country, as well as by Japanese engineers recently here on a visit, to the fact that unless the repeated occurrence of such agitation is stopped, it will prove very detrimental to our important trade relations with that country.

While the intelligent class of Japanese fully understand that the agitation is local, yet it is feared that if such agitation is persisted in by California and other Pacific States, it will eventually engender ill feeling between the people of both countries and certainly undermine the amicable relations and traditional friendship that have existed between the Japanese and United States heretofore.

The visiting Japanese engineers carry away with them a natural feeling of resentment against the people of California and perhaps against all Americans, as it becomes very difficult for the foreigner to draw a sharp line between the Americans in California and the Americans in other States.

This has already resulted in placing orders for materials in Europe which were originally contemplated to be placed in this country, and as already stated, unless the agitation is checked promptly, it will result in the loss of much of the ground that has been gained through many years of persistent effort by American manufacturers.

Our business with Japan has been continually increasing during recent years, and the exports of American manufacturers to Japan, principally of railway materials and iron and steel manufactures, have been as follows:

For the year			1903	$23,150,000
"	"	"	1904	29,060,000
"	"	"	1905	52,150,000
"	"	"	1906	35,000,000
"	"	"	1907	40,350,000

These figures do not include our exports of railway material to Manchuria, which have been made through Japanese firms who have had the absolute say as to where the contracts should be placed. As an instance, the Japanese have placed in this country during the year 1908, orders amounting to approximately $10,000,000 for railway materials for Manchuria.

As a further illustration of the growth of our business with Japan, the exports of locomotives from the United States to that country and her dependencies have been increasing as follows:

For the year			1901	39
"	"	"	1902	14
"	"	"	1903	32
"	"	"	1904	80
"	"	"	1905	151
"	"	"	1906	182
"	"	"	1907	*270

* About.

This phenomenal increase in the importation of American locomotives, as well as other railway equipment and machinery into Japan, is due very largely to the fact that the Japanese engineers who visited this country were treated by American manufacturers with the courtesy and consideration that they deserve, also to the sound judgment of the Japanese engineers and their appreciation of the simplicity and efficiency of American machinery.

It is needless to say that our interests will suffer greatly from the present agitation in California, in view of the fact that the Japanese people are highly sensitive, and are quick to resent the insulting attitude assumed by the authors of the bills now pending in the California legislature.

It occurs to us therefore that you could, through the editorial columns of your paper, remedy to some extent the damage already done to American interests by publicly assuring our Japanese friends that the American people as a whole hold them in the highest respect and esteem.

AMERICAN LOCOMOTIVE COMPANY.

The French Tariff on Machine Tools

Our readers will recall the publication on page 374, Vol. 31, Part 2, of a translation of the report of the French committee of machine-tool builders, wherein a large advance in the French tariff on machine tools was advocated.

We are informed by a French correspondent that the debate relative to this subject in the Chamber of Deputies is to

begin at about this time, if indeed it has not already begun, and he considers the situation critical.

In view of our own prohibitory tariff on machine tools, we fail to see how American machine-tool interests can offer any objection to this increase in the French duty, and as a matter of fact many of them have advocated a considerable reduction in our tariff rates.

The history of the export trade in machine tools during the past ten years has demonstrated that the American machine-tool industry is at least upon an even keel with the same industry in any European country. "We cannot eat our cake and have it, too," and the question before the machine-tool builders of this country is simply this: Is our existing machine-tool trade in France of sufficient value to offset the concession necessary to save it?

The Passing of the V-Thread

The action of the tap and die makers in adopting the United States standard thread as the only standard and relegating the V-thread to the list of "specials," to be had only on order and at an advance in price, marks a decided step forward in the effort to secure uniformity in machine products. As can be readily seen by the reasons given for this action, which appear elsewhere in this issue, the U. S. S. thread seems to afford the only satisfactory basis for a real standard thread, and has the advantage of being already largely in use.

Its adoption will cause less confusion than any other action which might have been taken, and some action was absolutely necessary to bring uniformity and order out of the chaos of the so-called standards as can be readily seen from an examination of the varying pitch or thread angle diameters of the different makers. No one can study these variations without being struck with the necessity of the action that has been taken.

While a standard V-thread pitch diameter might have been adopted, it would mean more confusion than the action taken and the foisting upon manufacturers of a standard which would not and could not be a V-thread in the true sense of the word.

The tap and die makers are to be congratulated on the broad stand they have taken, and it behooves all those who favor progress in machine construction to fall in line by ordering all taps and dies of the U. S. S. standard sizes.

As a matter of justice it should be added that this procedure was urged upon the tap and die makers by Professor Sweet thirty years ago, and of the many cases in which his mechanical judgment has been justified, we know of none more striking than this.

The Worcester Trade School

Plans for the inauguration of a trade school in the city of Worcester, Mass., are making progress. The city has passed an ordinance establishing a trade school under the State law and a board of thirteen trustees has been elected, of which Prof. M. P. Higgins is president. This board is now selecting a site for the school.

The Museum of Safety and Sanitation

An executive office for the administration and support of work of this museum has been opened at the United Engineering Societies Building, 29 West Thirty-ninth street, this city, and plans are now being prepared to insure its permanence as an institution.

As with so many public and philanthropic enterprises which have their headquarters in this city, the museum is to be supported by contributions of members of various grades, of which there are three, individual at five, sustaining at ten, and commercial at twenty-five dollars per annum.

The chairman of the committee on plan and scope is Prof. F. R. Hutton, while Dr. Wm. H. Tolman is director and secretary. A pamphlet defining the plan and scope of the museum has been prepared for free distribution, and it may be obtained by writing to the office at the above address.

Alexander Beaudry

Alexander Beaudry, president and treasurer of Beaudry & Company, Inc., Boston, Mass., died on February 10. His death came very suddenly.

Mr. Beaudry was 70 years old and was a well known figure in the machine business. He was of an inventive nature, and had to his credit about 28 patents on various kinds of tools. He invented the first hammer which bore his name about 1880, and from that time on brought out various types of hammers and presses.

While Mr. Beaudry was president and treasurer of his concern he had not been actively identified with it for some years, so that his death will not in any way have a bearing on the business policies of the concern, as the present management will continue in charge.

New Publications

PIPES AND PIPING. By Hubert E. Collins. 140 5x7-inch pages; 75 illustrations; indexed. Hill Publishing Company, New York City. Price, in cloth, $1.

Another of the *Power* handbooks is devoted to pipes and piping. It gives general rules for the design of high- and low-pressure steam piping in power plants, considers the forces involved and how they can best be met, describes high-pressure steam-pipe flanges, how to deal with vibration, directions for connecting boilers to steam mains, accidents due to faulty piping, effect of superheated steam on cast-iron valves and fittings, and a lot of other information which the engineer who has, or expects to have, anything to say about the putting in of piping systems should have in a convenient form for reference. It is compiled largely from the pages of *Power* and the material has had the benefit of critical consideration by the practical clientele of that paper.

ERECTING WORK. By Hubert E. Collins. 140 5x7-inch pages; 110 illustrations; indexed. Hill Publishing Company, New York City. Price, in cloth, $1.

A number of monographs have been prepared under the direction of the editors of *Power*, dealing with various phases of power-house and kindred work. One of the first of these is the book under review, which deals with the handling of large machinery from the cars to the place where it is to be used, and of its erection at that point. It tells how foundations should be put in, describes the different knots and hitches used with ropes, treats upon the handling of heavy machinery through city streets and up inclined runways into the plant, where a gin pole may be used to advantage, explaining how to rig it, building up flywheels, erection of high-speed center-crank engines, etc. It is largely compiled from the pages of *Power* and brings together in a convenient form a lot of information which has not been easily accessible heretofore.

KNOCKS AND KINKS. By Hubert E. Collins. 137 5x7-inch pages; 82 illustrations; indexed. Hill Publishing Company, New York City. Price, in cloth, $1.

In a running engine a knock is the first indication that something is wrong. It may or may not be serious, but is always annoying, and every operating engineer of any experience has had his share of trouble in running down such a knock and removing its cause. One of the *Power* handbooks is devoted to this subject. It begins with a consideration of the causes of knocks, contributed to the columns of *Power* by C. J. Larson, until recently the head erecting engineer for the Allis-Chalmers Company. The effect of the inertia of the moving parts is explained and a long chapter devoted to the ready detection and remedy of knocks, taking the subject up analytically and considering the effects of lack of alinement in the rods, of parallelism in boxes, etc., so that one can intelligently diagnose a case. Many instances of troublesome knocks which have been detected and remedied are recounted and will furnish clues to the detection of those which are troubling users of the book.

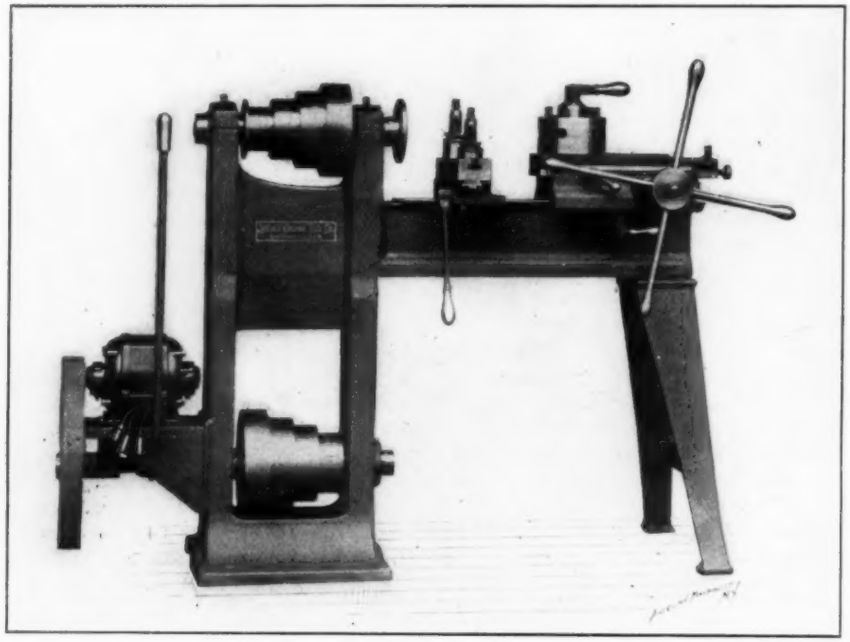
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Motor Driven Turret Lathe

A brass-working turret lathe of rather novel design to accomodate a constant-speed motor has been brought out by the Dreses Machine Tool Company, Cincinnati, O., and is shown herewith. The motor is 1½ horsepower, of the alternating, high-speed type, driving the lower cone through a rawhide pinion and gear.



MOTOR-DRIVEN BRASS-WORKING TURRET LATHE

To avoid the comparatively slow starting and stopping of the motor a friction clutch operated by the long lever shown on the left-hand side, connects and disconnects the lower cone pulley. The lower cone is placed as near the floor as possible in order to have a long driving belt and to avoid vibration. This is to avoid the vibration that might be caused by having the motor in the head. The turret lathe is of their standard 13-inch design.

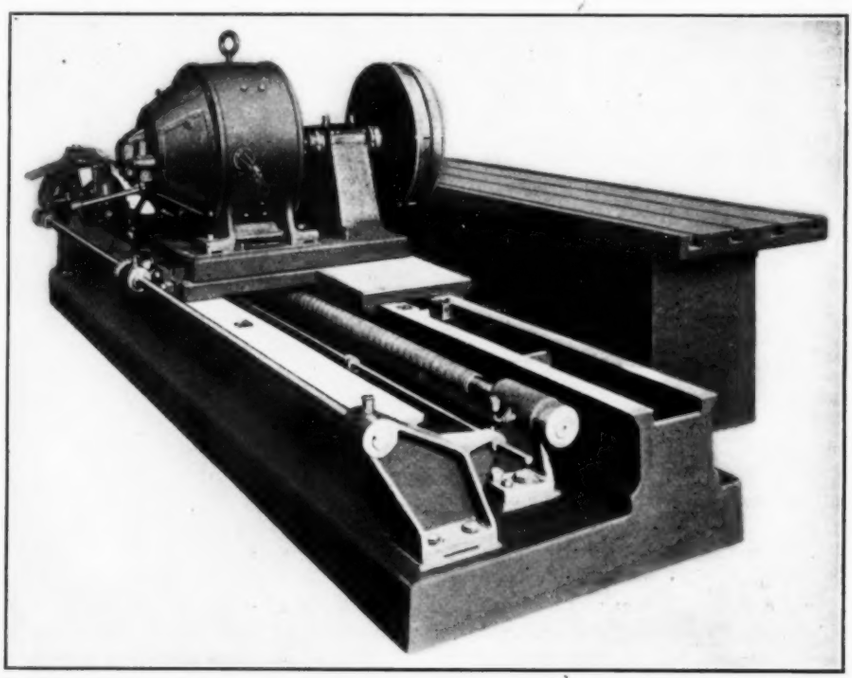
Controllers for Alternating Current Motors

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has developed a line of drum controllers for use with two- or three-phase, slip-ring motors, operating cranes or in similar places where frequent stopping and starting are necessary. The drum consists of a three-pole primary, a combined line and reverse switch, and a cylinder for controlling the secondary starting and regulating resistance, mounted on the controller shaft and driven directly by the operating lever. Some are open and others immersed in oil according to the current handled.

Motor Driven Traveling Head Face Grinder

A very satisfactory type of traveling-head grinder is here illustrated, known as a face grinder. It is particularly adapted to the work of structural iron workers, bridge builders, safe makers and manufacturers in kindred lines, where it is necessary to grind materials that are liable to be too hard or too inconvenient to be machined.

As shown in the illustration, the grinding head is direct connected to an electric motor, which, together with a very heavy outboard bearing, is mounted on a large base moving on ways. The motor has an extended shaft to carry the grinder chuck. The work is stationary, being bolted to the large platen in front of the 22-inch emery ring, while the ring rotates and also moves slowly back and forth from end to end of the platen. The reversing is done either by a hand lever or by automatic stops. The longitudinal travel of the grinder is obtained from the feed screw shown. The table travel is 20 feet per minute. The lead screw

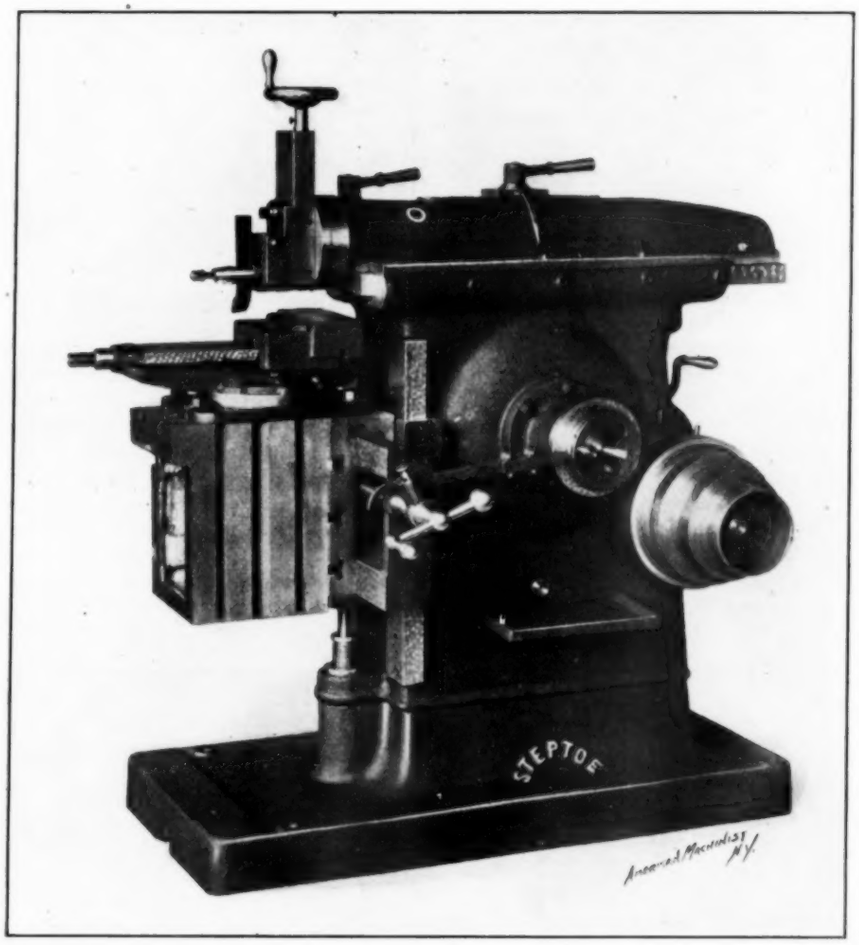


MOTOR-DRIVEN TRAVELING-HEAD EDGE GRINDER

is driven by a second motor not shown in the illustration. The grinder is driven by a standard Westinghouse type "S" compound-wound, direct-current, 10-horsepower, 1100 r.p.m., totally inclosed motor. Where required, an alternating-current motor may be supplied in place of the direct-current motor. The size of the motor to operate the lead screw is dependent upon the nature of the work to be performed. This grinder is a 102-inch face grinder as manufactured by the Diamond Machine Company, of Providence, R. I.

A 16-inch Back-geared Shaper

This shaper has, in addition to its single-gear ratio of 6¾ to 1 a back gear which increases this to 20 to 1. The back



A 16-INCH BACK-GEARED SHAPER

gears consist of a sleeve to which two gears are attached. These gears are splined to the shaft, and are therefore constantly running with it. By means of a second sleeve these gears are shifted at the will of the operator, by a lever at the back of the column, which is placed in an upright position within easy reach of the operator. The speed is thereby increased or decreased, and the power increased or decreased as may be desired.

The feed plate is different from the usual design. The feed eccentric is pivoted, so that it can be swiveled in any direction. The holes in the plate are drilled and reamed tapered to receive a tapered pin to take up any wear which may occur. The holes are drilled and numbered in accordance with the teeth in the feed ratchet, making it very easy to secure any desired feed.

The vise base is plainly graduated and the upper jaw has two bolts to allow clamping to lower jaw, with the object of overcoming the tendency to raise the work as it is tightened in the vise.

Another convenient feature is the locking of the head, which can be instantly loosened or tightened by the handle directly behind it. This operates an eccentric stud and pulls the head squarely against the front of the ram.

The length of stroke is varied by means of the lever projecting through the feed plate and can be performed while the machine is in motion. The device in the bull gear is self-locking, and is held firmly in position as soon as the adjusting lever is taken off of the shaft, thus avoiding the necessity of locking the shaft in position.

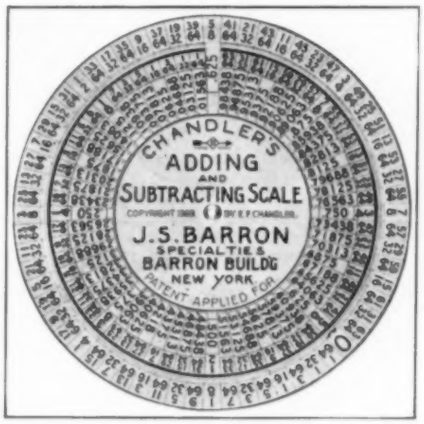
The telescopic screw under the table is fully inclosed, thereby avoiding the possibility of oil and chips getting under the base.

The operating side of the machine is very rigid, being braced by the basin shaped projection, in which a large amount of metal has been placed.

The shaft bearings are provided with cast-iron bushings. These bushings are made a tight fit, and are pressed in place, but can be very readily removed, and replaced at any time. The shaft bearings are provided with ring oilers. The rings are made of wide strips of brass, thereby giving a liberal contact on the shaft, and distributing the oil more freely than a round ring. The shaper is made by the John Steptoe Shaper Co., Cincinnati, O.

A Slide Rule for Adding or Subtracting Fractions

The adding and subtracting of fractions are probably responsible for more errors than almost any other of the minor problems in arithmetic, and anyone who has much of this to do will welcome the little slide rule shown with this. It is very easily used, is only 3¼ inches in diameter, so that it may be readily carried in the vest pocket, and all the figures are large enough to be clearly seen without the aid of a glass. With this all the common



A SLIDE RULE FOR ADDING

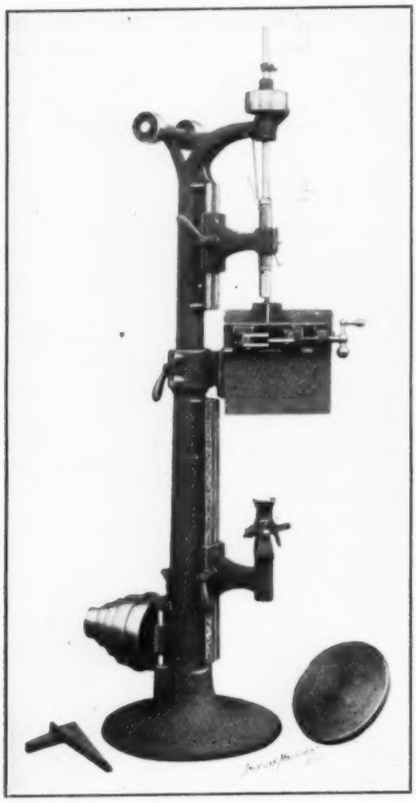
fractions from eighths to sixty-fourths can be readily added or subtracted and the answer obtained in either fractions or decimals. Being circular, there is no slide to pull out and the whole operation is continuous. It also makes a very convenient table of decimal equivalents, which will always be at hand.

With a little practice it becomes very easy to add a string of fractions, one after the other, the sum of the fractions being added always appearing on the lower disk and the difference on the upper disk, so that there is hardly any excuse for confusion. For example, to add 7/16 and 9/64. Turn 9/64 on the inner scale to 7/16 on the outer scale and 37/64 will show on the lower disk opposite the slot. To subtract 9/64 from 5/8. Turn the slot to 5/8 and see what fraction is opposite 9/64 on either scale, i.e., 31/64. It was

designed by E. S. Chandler, and is being marketed by J. S. Barron, Barron building, New York.

A Drill Press with Convenient Attachments

This drill press, which will handle any drill up to 7/8-inch, has several novel features which should prove very convenient. The cone and drive pulleys are mounted on a bracket having a vertical adjustment of 3 inches, to take care of the belt tension. The upper table swivels to any angle and also swings around the column. The lower arm can carry the round table or the 3-point drilling fixture, having a pointed center, a cup center and a V always at hand.



A CONVENIENT DRILL PRESS

A handy drilling vise is shown attached to the square table and the square, or drilling gage, shown by the base of the machine, can also be used to advantage in many cases. The spindle and its head have the usual adjustments and the whole machine seems to have been designed for the convenient handling of all kinds of work that is likely to come along. It is built by the Rockford Machine and Shuttle Company, Rockford, Ill.

Double Head Facing Lathe

This lathe is designed for facing flanges, girders or similar work held in stationary fixtures on the bed, although turning can be done if desired, as a regular carriage is provided for that purpose. A lead screw also allows screw cutting at any time. By using a traveling-head boring bar and fastening the cylinder to the bed, it becomes a substantial boring machine.

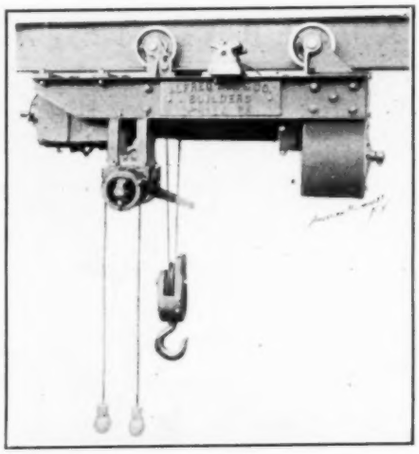
It is made from the standard pattern lathe, raised to swing 62 inches over the bed and 50 inches over the carriage, and each face plate carries a facing head with a star feed, being a part of the face plate itself.

Each headstock is movable by rack and pinion, has back gearing of 12½ to 1 and triple gearing of 40 to 1; front bearings are 6¼x10½ inches and rear bearings 4½x7 inches. The distance between facing heads on a 22-foot bed is 13 feet; the total weight 24,000 pounds.

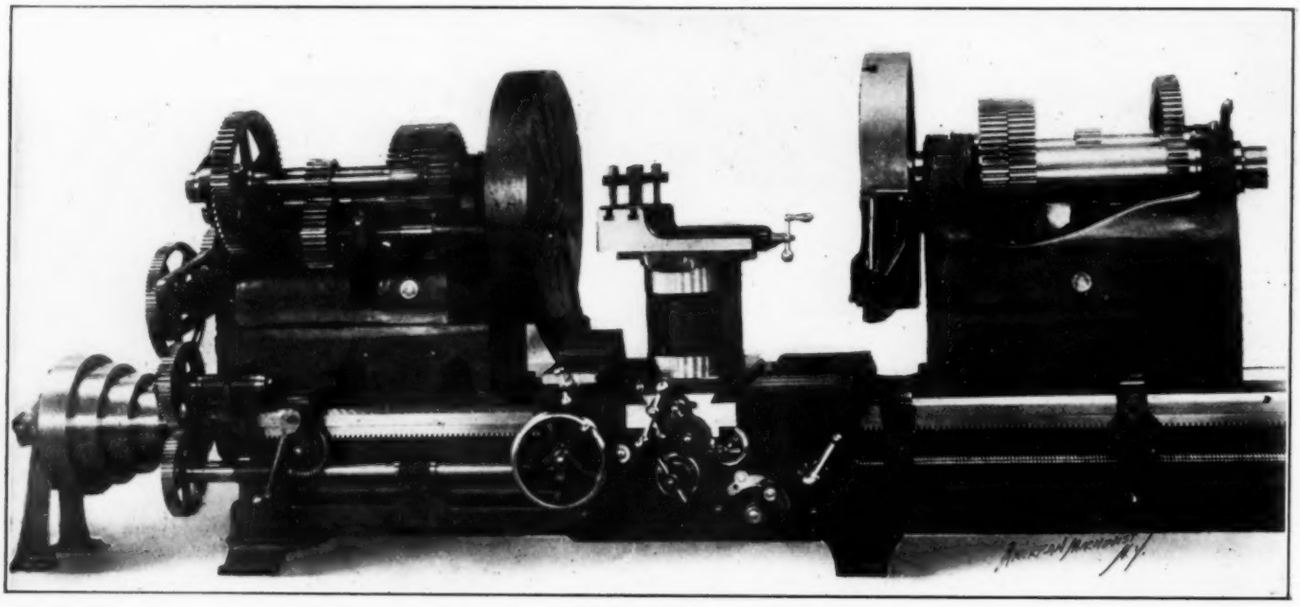
Power is applied through a splined shaft running into the center of the bed and the heads run in opposite directions to equalize the strain on the fastenings holding the work. It is built by Fay & Scott, Dexter, Me.

Monorail or I-Beam Hoists

The illustration shows one of a series of traveling hoists, built to run on the lower flange of an I-beam, either straight or curved, and to be moved either by hand or power. They are built for strength and durability and require a small amount of head room. All gears are either spur or internal, having teeth cut from solid steel blanks. The hoisting drum is grooved to prevent overlapping of the rope and a limit switch prevents overrunning of the ropes on the drum. Two brakes are provided, one operated by a solenoid magnet and the other of the friction-disk type, to prevent running down or racing with the load. They are built by Alfred Box & Co., Philadelphia, Penn.



ELECTRIC HOIST FOR I-BEAMS



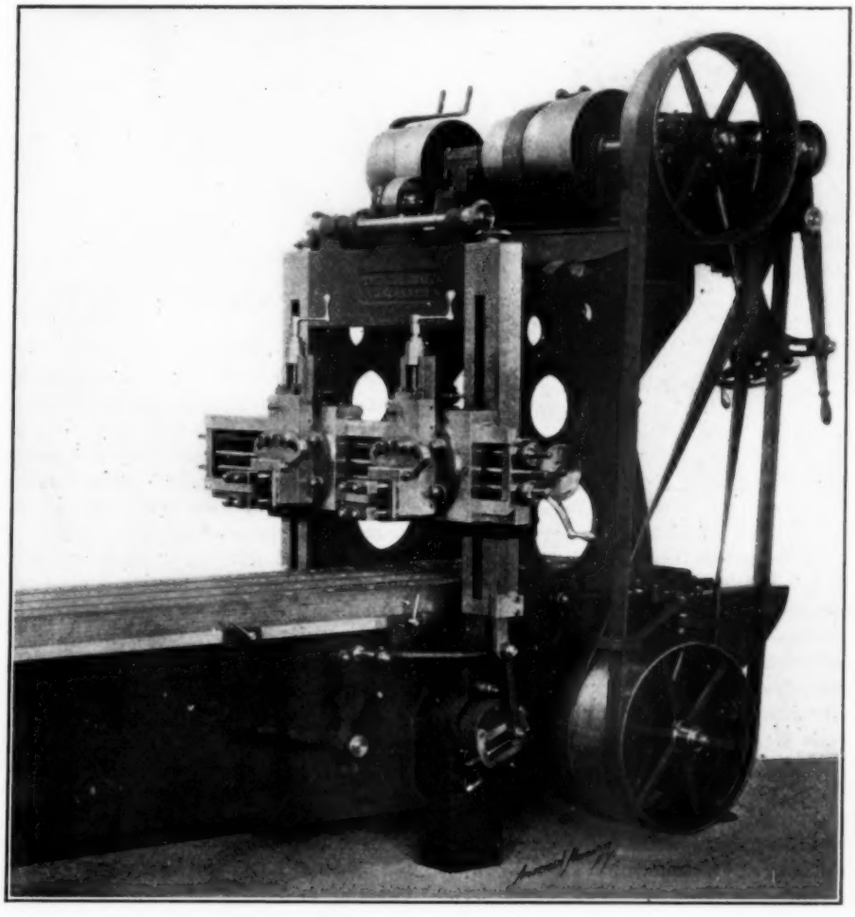
FAY & SCOTT DOUBLE-HEAD FACING LATHE

Belt Driven, Variable Speed Planer

We illustrated some months ago the motor-driven variable-speed device used by the G. A. Gray Company, Cincinnati, O., in connection with their planers. The illustration shows this arranged to be driven by belt from the line shaft, by means of a pair of tight and loose pulleys, mounted directly on the constant-speed shaft, as shown. These are of the differential type, the loose pulley being smaller than the tight, to relieve belt pull when not actually driving, a bevel shoulder between them facilitating shifting the belt.

The belt shifter for the tight and loose pulleys is entirely universal, and can be set to shift the belt whether the planer stands in front of or behind, or even directly underneath the line shaft. The handle for controlling this shifter is conveniently located at the front side of the machine.

This variable-speed planer, like our large sizes, gives four cutting speeds with a constant return, and we call special attention to the fact that on all of our variable-speed planers the speeds can be changed without shutting off the power and without even stopping motion of the planer, thus saving the time which otherwise would be wasted in waiting for the flywheel and other revolving parts to come to rest.



BELT-DRIVEN VARIABLE-SPEED PLANER

A New Method of Grinding Formed Cutters

The tilting grinding spindle of the tool-room grinders built by the Walker Grinder Company, Worcester, Mass., and illustrated on page 118 is very convenient for many classes of work, but particularly so for sharpening formed cutters, such as gear-cutter hobs. With the attachment shown in Fig. 1 any formed cutter, having either straight or spiral flutes can be readily ground, the attachment shown automatically taking care of the spiral of the flute.

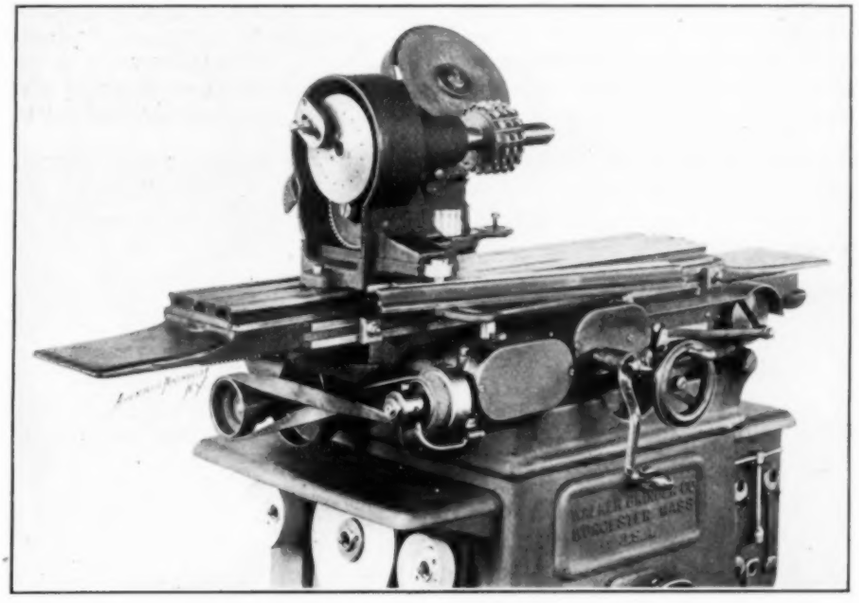


FIG. 1. GRINDING FORMED CUTTERS BY A NEW METHOD

This attachment consists of an arbor for holding the cutter to be ground, and carrying an index plate at the back. The indexing arm is geared to the gear shown below the index plate, this in turn meshing with a rack which projects through the front and carrying the pin, which engages in the sliding block. This block works in a corresponding groove in a sort of taper attachment, which can be set to any desired angle according to the angle of the flute in the cutter. In this way the rack

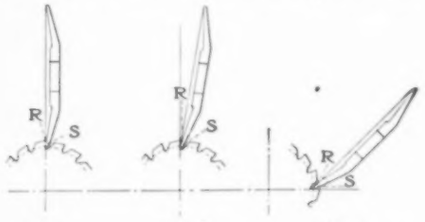


FIG. 2 FIG. 3 FIG. 4

DIFFERENT METHODS OF GRINDING

is moved in and out as the table carries the cutter past the grinding wheel and revolves the cutter so as to maintain its contact between its cutting edge and the grinding wheel. After one flute has been ground, the cutter is moved with reference to the index plate, according to the number of flutes, and the operation proceeds as before.

Figs. 2 and 3 show the usual method of grinding formed cutters with the flat side of the grinding wheel, the second showing a method of grinding by means of a tilted

grinding spindle, the intention being to use a vertical feed on the line and to surface-grind the teeth from the top downward, the wheel clearing itself so that the grinding will be a true plane until the wheel has worn beyond the line *R S*. This is open to the objection of requiring a vertical feed.

In Fig. 4 is shown the principle employed in the Walker grinder, whereby the face of the tooth to be ground is placed in a horizontal plane, the grinding spindle being set at a vertical angle, conforming to the angle of the groove in the cutter.

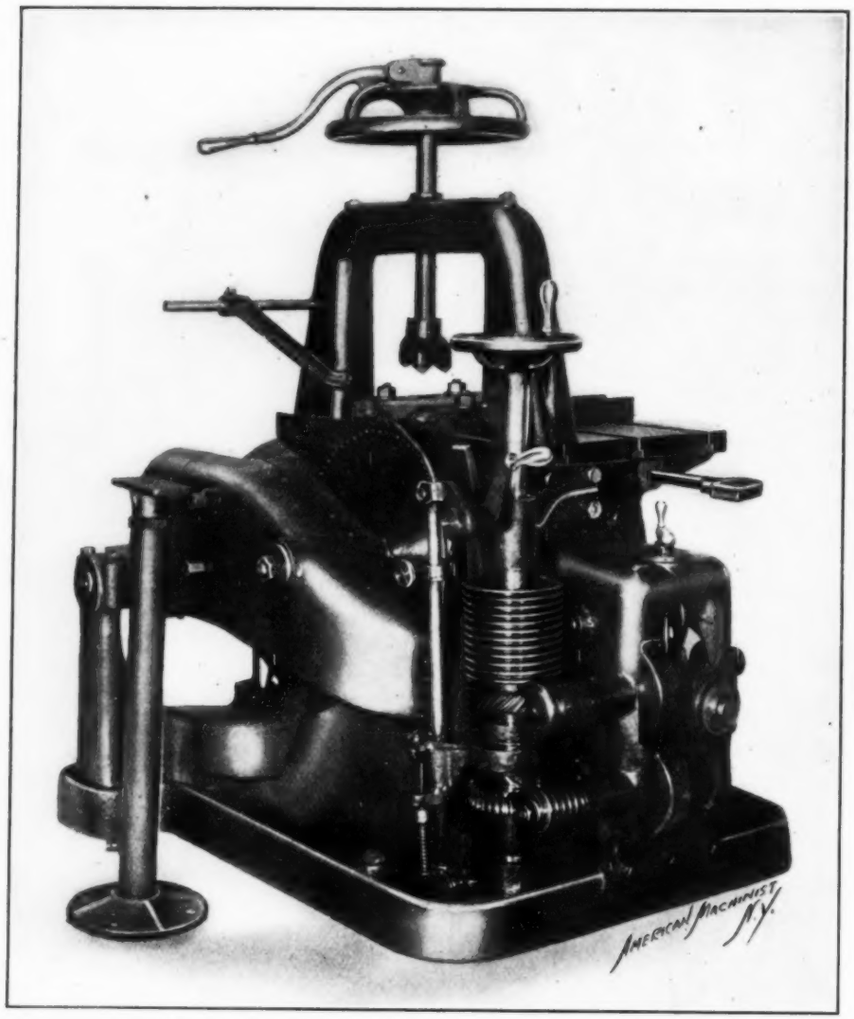


FIG. 1. THE IMPROVED LEA-SIMPLEX COLD SAW

The radial face of the tooth is by this method, *surface-ground* by the beveled periphery of the wheel, and it will be seen that the wear of the wheel simply reduces its diameter, the outer corner becoming but slightly rounded.

Among other advantages claimed by this method are the reduction of heat, the ability to grind into a sharp corner, and to grind a spirally grooved cutter, which would be impossible by either of the other two methods above mentioned. Ordinarily it is only possible to grind a formed cutter by the method outlined in Fig. 2, this being on account of grinders having no provision for obtaining the necessary adjustment of the grinding spindle at a vertical angle.

The index plate is made detachable, and the index pin and bearing have an adjustment in a radial direction, so that it can be set for the various diameters of the hole circles. Each circle of holes is divided to correspond to the number of teeth in the cutter to be ground, and other index plates can be substituted. Provision is made for grinding taper cutters by setting the adjustable top of the platen at an angle. Also on spirally grooved cutters the grinder head can be set at any necessary horizontal angle by swiveling the housing which supports the grinder head.

Further details of the operation of this attachment are obvious, and it should be borne in mind that the face of the cutter tooth is surface-ground, using automatic cross feed in the regular manner. The sharp corner of the grinding wheel is maintained by periphery wear. There is practically no danger of drawing the temper of the cutter, and when the tooth is ground it presents a keen edge and shows no evidence of rounded edge or other distortion.

Improvements on the Lea-Simplex Cold Saw

These machines now have an entirely new feed mechanism driven by means of Sellers disks. These are unaffected by oil which occasionally interfered with the old cone feed. The upper shaft, carrying the constant-speed disk is driven by an automobile chain coming from the drive shaft on the other end of the machine. The intermediate disks are made of soft steel, the side which bears on the bronze disk being tapered about 2 degrees. These disks are mounted on a tool-steel shaft which runs in bronze bushings mounted in the swing arm.

In order to give greater tension on the disk the operator holds the knob which stops the shaft and screws up the disk immediately behind it. By turning the ball crank on top of the box and raising and lowering the swing arm a variation of

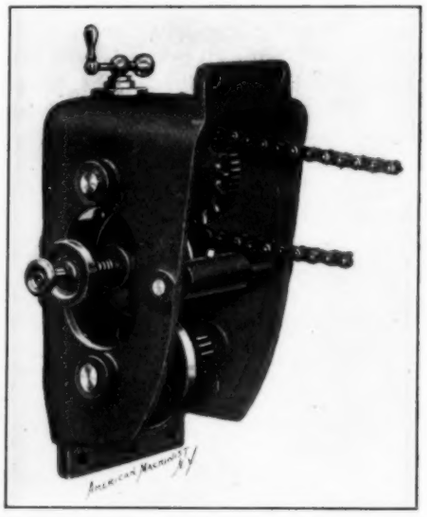


FIG. 2. DETAILS OF THE FEED BOX

10 to 1 can be obtained. The rate of feed per minute is registered on the dial on the front of the box so that the operator can tell at a glance exactly what is being done. Just above the worm which drives the feed, is another shaft with a spiral gear, running at a constant speed, and operating the power return. Both the worm and the spiral gear shaft are fitted with roller thrust bearings.

Another improvement has been made in the form of a V-block used. This can be used for either round or square stock, the two tapered edges being put together, allowing the stock to come down until it almost touches the table and in cutting square stock or structural metal the two castings are turned end for end which practically makes two knee plates. The holes which hold the block to the table are oblong so that the blocks can be swiveled to 45 degrees. This is made by the Lea Equipment Company, 136 Liberty street, New York.

Proposed Elimination of the Old V Thread in Taps and Dies

For a number of years the tap- and die-makers of this country have had under consideration the advisability of discontinuing the regular manufacture for stock of V-thread taps and dies, and the general adoption of the United States Standard or Sellers form for all 60-degree screw threads. There can be no question but that such action, as now definitely decided upon, will be of wide importance to tap and die manufacturers, users and dealers.

The "V-standard" No Standard

The V-standard so called is a "standard" existing only in theory; in practice the V-thread, nominally an equilateral triangle in section, is flatted at the top an amount varying with the practice of the different manufacturers. It is, of course, recognized that the slightly flatted top is an essential feature of this thread, as it is a sufficient surface to give satisfactory results while another manufacturer may cut the thread a little deeper, and still another not quite so deep. No two work to the same dimensions and the result is that the actual thread diameters, measured in the V, differ with every make. This fact is well illustrated by the accompanying table which gives the diameters adopted by various makers whose names and products are known throughout the manufacturing world.

A comparison of these figures with the true or theoretical pitch-line diameters of the perfectly sharp V, as given in the fourth column from the right of the table, will reveal some interesting irregularities. The values in this column are equivalent to the outside diameter of the threaded piece less the depth of a single thread, as computed by the formula

$$Pitch\ diameter = D - \frac{0.866}{P},$$

where P equals the number of threads per inch and D the outside diameter. The columns headed A, B, C, etc., represent the actual sizes worked to by the different tap manufacturers. Thus in column A will be found the diameters adopted by one concern, while column B shows the practice of another maker; and so on across the table.

Considering, for example, the ¼-inch 20-thread size, the tabulated data show that this is made all the way from 0.0023 to 0.0103 inch larger than the standard pitch-line diameter; and, in the case of the ½-inch 12-thread, the range throughout the different lines is from 0.0062 to 0.0142 inch oversize in the thread angle. The ¾-inch 10-thread dimensions show an increase over the theoretical diameter ranging with different makers from 0.0068 to 0.0136 inch and in the case of the 1-inch 8-thread size the oversize allowance is from 0.008 to 0.0182 inch. The variation for other sizes may be readily found by merely subtracting the values under the alphabetically headed columns from the corresponding sizes given in the column at the right of the table.

Impracticability of the V-standard

It is obvious upon inspection of the figures presented in this table that the term "V-standard" is a misnomer; and that an anomalous condition of affairs is created by the perpetuation of this irregular or alleged standard. Here, in short, is a so-called standard which it is impracticable to follow faithfully and to which, therefore, all V-thread taps and dies are necessarily an approximation only. Hence, each manufacturer has developed a "standard" of his own and the resulting lack of interchangeability between the products of these different makers has been a constant source of expense and inconvenience both to users and to the manufacturers themselves. It has made it impracticable in shops where screws are required to fit mechanical impossibility to maintain the size of a tap with perfectly sharp threads while a single hole is being tapped; the removal of the metal during the operation causing the sharp tops to be worn away and the original diameter to be lost almost from the outset.

Consequently, as noted, it has been customary for the different manufacturers to leave the thread top slightly flatted, and this means that if the external diameter is made to size the diameter when measured at the pitch line in the V is somewhat larger than the true, theoretical diameter.

Differences in Diameter

In cutting down the V-thread in the tap, some makers stop at one point, some at another. One concern may cut down to a pitch diameter 0.010 inch over the theoretical size, believing that the flat thus left at the top of the thread presents just properly and where for illustration a certain line of taps is used, to make satisfactory use of another manufacturer's taps as the screws will then either enter the tapped holes too freely, or possibly not enter at all. It has necessitated, therefore, the carrying of large stocks of taps and dies by all concerned and to a considerable extent has restricted the market in which purchasers of these tools can secure their supplies.

Two Possible Courses

In considering the possibility of eliminating this undesirable state of affairs, two courses have been fully weighed and discussed by the tap and die manufacturers: one, the actual standardization of the V-thread; the other the adoption of the United States standard form of thread for all regular tools and the cessation of the manufacture of V-thread taps and dies

Size Threads	A	B	C	D	E	F	G	H	I	J	Theoretical Diameter of Sharp V Thread Measured in the Angle.	Pitch Diameter U. S. S.	Actual Pitch Diameter of One Makers V Thread.	Difference Left to Tap Out.
¼—20	0.2107	0.217	0.214	0.2147	0.212	0.209	0.2147	0.214	0.217	0.217	0.2067	0.2175	0.2107	0.0068
5/16—18	0.2683	0.275	0.275	0.2724	0.270	0.267	0.2724	0.2755	0.2755	0.2745	0.2644	0.2764	0.2683	0.0081
⅜—16	0.3264	0.331	0.332	0.3290	0.327	0.325	0.3289	0.333	0.331	0.3315	0.3209	0.3344	0.3264	0.0080
7/16—14	0.3822	0.386	0.386	0.3836	0.382	0.380	0.3836	0.3875	0.386	0.386	0.3756	0.3911	0.3822	0.0089
½—12	0.4351	0.438	0.441	0.4378	0.4355	0.434	0.4358	0.442	0.439	0.441	0.4278	0.4459	0.4351	0.0108
9/16	0.4963	0.500	0.501	0.5003	0.4978		0.4983	0.50125	0.502	0.500	0.4903	0.5084	0.4963	0.0121
⅝—11	0.5525	0.556	0.559	0.5563	0.554	0.554	0.5543	0.55925	0.559	0.558	0.5463	0.5659	0.5525	0.0134
11/16	0.6153	0.619	0.625	0.6188	0.6168		0.6168	0.6217	0.622	0.6245		0.6285	0.6153	0.0132
¾—10	0.6702	0.673	0.671	0.6734	0.6715	0.671	0.6714	0.6715	0.677	0.671	0.6634	0.6850	0.6702	0.0148
13/16	0.7321	0.736	0.732	0.7359	0.734		0.7339	0.734	0.7395	0.7315				
⅞— 9	0.7875	0.789	0.795	0.7888	0.788	0.788	0.7868	0.796	0.796	0.795	0.7788	0.8028	0.7875	0.0153
15/16	0.8495	0.851	0.854	0.8513	0.8508		0.8493	0.858	0.858	0.8535				
1— 8	0.9017	0.902	0.900	0.9018	0.902	0.901	0.8998	0.901	0.910	0.900	0.8918	0.9188	0.9017	0.0171
1 1/16														
1⅛— 7	1.0103	1.011	1.024	1.0113			1.0021	1.0135	1.022	1.022	1.001	1.0322	1.0103	0.0219
1 3/16														
1¼	1.1347	1.136	1.146	1.1363		1.137	1.1271	1.1385	1.147	1.145	1.126	1.1572	1.1347	0.0225
1 5/16														
1⅜— 6	1.2422	1.241	1.251	1.2407			1.2387	1.243	1.249	1.249	1.230	1.2667	1.2422	0.0245
1 7/16														
1½	1.3678	1.366	1.378	1.3675		1.368	1.3637	1.368	1.376	1.377	1.355	1.3917	1.3678	0.0239
1⅝— 5	1.4646	1.462	1.473	1.4618			1.4598	1.464	1.472	1.4715	1.467	1.4951	1.4646	0.0305
1 9/16	1.5878	1.587	1.581	1.5868			1.5848	1.589	1.597	1.5795	1.576	1.6201	1.5878	0.0323
1¾— 4½	1.6904	1.693	1.692	1.6926			1.6928	1.6947	1.702	1.690	1.682	1.7306	1.6904	0.0402
2	1.8219	1.818	1.833	1.8176			1.8187	1.8197	1.828	1.831	1.807	1.8557	1.8219	0.0338

ANGLE SIZE "V" THREAD.

Comparative Angle Sizes of "V" Threads as Made by Different Manufacturers of Taps.

except for special work. The pursuit of the former course would mean the establishment of a uniform pitch-line diameter for all V-thread taps and dies of given size and this would necessarily involve a change in the present practice of each manufacturer concerned, some having to cut their V-threads smaller and some larger than heretofore in order to conform to the dimensions decided upon. At the best the result could be nothing better than a compromise measure serving to perpetuate a form of thread having at the present time little excuse for existence in connection with regular lines of work.

Furthermore, during the transition period, the standardization of V-thread taps and dies would create quite as many, and as serious, difficulties in establishments using that form of thread as would be involved in the straight out-and-out adoption of the United States standard thread. That is, it would constitute an important departure from present practice so far as concerns the shops in question; and yet, although the advantage of V-thread uniformity would thus be secured, there would still remain the illogical, expensive and generally unsatisfactory situation of two standards existing for similar classes of work.

Recognition of the Advantages of the United States Standard

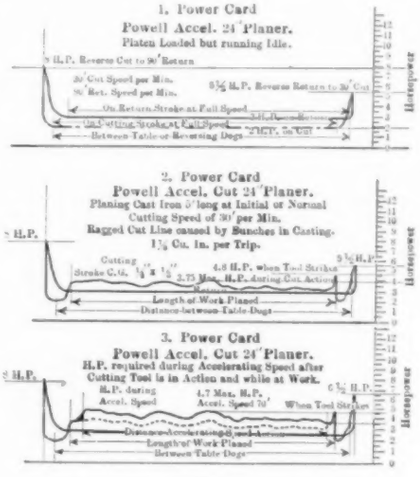
There can be no question as to the supremacy of the United States standard form of thread. Devised over 40 years ago and recommended by the Franklin Institute for general adoption by engineers, it has become the standard of the United States Government, and is used by practically all the railroads, bolt and nut makers and progressive manufacturers of the country.

In 1898, the International Congress of Engineers convening at Zurich, adopted this form of thread as the best for metric sizes and pitches, and it is now in almost universal use throughout the continental countries. More recently the Association of Licensed Automobile Manufacturers has adopted it as the standard of the organization, and in 1907 it was accepted by the American Society of Mechanical Engineers as the standard form of thread for machine screws.

For many years this standard form of thread with depth equal to Pitch $\times$ 0.6495, has been supplied by tap and die manufacturers, with practical interchangeability. The outline of the thread is such that it may be cut to the correct theoretical depth and to the true pitch-line diameter without the allowances found necessary when cutting the so-called sharp V-thread. It will be seen by comparing the pitch diameters of the United States Standard with even the largest of the V-thread diameters, that the United States Standard is a little larger in every case. This allows the retapping of any V-thread hole to bring it up to standard size, and avoids the necessity of discarding any machine parts but the screws or bolts. The United States Standard form of thread has been and is, adhered to as a standard, and as such should render entirely feasible the elimination altogether of the V-form of thread for regular bolts, nuts and screws.

Rapid Cutting of Metal—Some Interesting Tools and Machines

Some interesting examples of the rapid cutting of metal were given at a demonstration of Blue Chip steel by Wheelock, Lovejoy & Co., at the shops of the Powell Planer Company, Worcester, Mass. One of the new Powell planers was at work, showing the results obtained by accelerating the speed in the cut. All who are familiar with planer work realize the saving of a slight increase in cutting speed over a very much larger increase in the return speed. This has been taken advantage of by Mr. Powell by using a device which speeds up the table as soon


1. Power Card
Powell Accel. 24" Planer.
Platen Loaded but running Idle.
2. Power Card
Powell Accel. Cut 24" Planer.
Planing Cast Iron 5' long at Initial or Normal Cutting Speed of 30' per Min.
Ragged Cut Line caused by Bunches in Casting.
1¼ Cu. In. per Trip.
3. Power Card
Powell Accel. Cut 24" Planer.
H.P. required during Accelerating Speed after Cutting Tool is in Action and while at Work.
Horsepower

RAPID CUTTING OF METTAL

¼" Cut, ⅛" Feed—60" Long = 1⅞ Cubic Inches per Cutting Stroke.

Ordinary.	Quick Return.	Accelerating Cut.
1' cut = 2 sec. 1' ret. = 0.666 sec. } = 2.666 sec.	1' cut = 2 sec. 1' ret. = ⅓ sec. } = 2.333 sec.	1' cut accel. 70' = 0.8571 1' ret. 90' = 0.6666 } = 1.5237 sec.
5' trip = 13.333 sec.	5' trip = 11.666 sec.	5' trip = 7.6188 sec. per trip.
13.333 / 60 sec.	11.666 / 60 sec.	7.6188 / 60 sec.
4.5 = number round trips per minute.	5.145 round trips per minute.	7.874 round trips per minute.
4.5 × 1⅞ cu. in. removed per trip. = 8⅜ cu. in. per min. = 506 ⅛ cu. in. per hour. (1250 lb.) = 5064 cu. in. in 10 hours.	*Comparison:* 180° ret. = 5.145 trips per min. 90° ret. = 4.5 trips per min. Gain = 0.645 = 14.3% Number cu. in. metal removed per min. = 9⅝ (1450 lb.) = 5796 cu. in. = 10 hours.	*Comparison:* Accel. cut = 7.874 trips. 30' cut, 90' ret. = 4.5 trips. Gain for accel. = 3.375 trips, or over 40 per cent. gain. Accel. cut = 7.874 trips. 180' ret. = 5.145 trips. Gain for accel. = 2.729 trips. Number cu. in. metal removed per min. = 14.75 (2200 lb.) = 53% = 8850 cu. in. = 10 hours.
5064 cubic inches = 10 hours.	5064 cubic inches = 8¾ hours.	5064 cubic inches = 5¾ hours.

COMPARISON BETWEEN HIGH-SPEED PLANER TYPES.

Ordinary type, 30-foot cut, 90-foot return. Quick return, 30-foot cut, 180-foot return. Accelerating cut where the cutting tool is speeded up to 70 feet after the tool has entered the work at 30 feet; return speed unchanged 90 feet.
Work being planing cast iron 5 feet long.

as the tool is well entered in the cut. In this way the tool is not subjected to any unusual shock in striking the work, and, once buried in the cut, the increase in cutting speed shows no tendency to injure the tool, indicating that the shock of entering the work is what limits the cutting speed of planers.

The following results show what has been obtained with this planer, used with and without the accelerating device.

Mr. Powell has also worked out some interesting diagrams showing the power consumed by a planer under varying conditions. It will be noted that, even with the accelerated cut, the power consumed in cutting is considerably below that required at the reversal so that any motor which will handle the planer run in the ordinary way, will have no trouble when the accelerating device is in use.

A large Lo-Swing lathe, turning long chips which were blue, in true accord with the name of the tools used, completed the working exhibit. Some of these chips were from 110-point carbon steel, giving a good indication of the power of the lathe, as well as the cutting qualities of the tools.

Large cutting and stamping dies, as well as small milling cutters of Blue Chip steel were exhibited by E. C. Bliss, of Providence, R. I., while the steel displayed gave a good idea of the variety of uses for which steels are made.

Among these is the nonsinkable steel, which does not refer to its low specific gravity, but to its high resistance to compression, being specially prepared for jewelers' drop-hammer dies, and named because it does not "sink" in under the pressure exerted by the blow. The nonshrinkable, made for cutting and punching dies, is a more understandable name. Cold saws running up to 18 inches in diameter, said to be the largest solid high-speed cold saws made, and as a contrast, some for jewelers use, 2⅛ inches in diameter by 0.004 inch thick.

It is interesting to note that about 900 tons out of a total of 1400 tons of steel used in hacksaws in this country are supplied by Wheelock, Lovejoy & Co. This is known as hack-saw stock.

They also make a cold-rolled hack-saw stock, coming in rolls of 500 feet, and which must be free from twist or wind so as to be passed readily through the cutting machines, and supply about 250 tons of this.

It is intended to continue these exhibits in Springfield, Hartford and other cities, and they should certainly stimulate interest in the progress that has been made in the rapid removal of stock with machinery of various kinds.

The value of automobiles imported into this country during 1908 amounted to $22,000,000 which was $1,500,000 less than the year 1907.

Business Items

Corin & Linder, Goteborg, Sweden, have opened a machinery agency and want to hear from firms not represented in Sweden.

C. W. Leavitt & Co., dealers in ores, metals and alloys, will after March 20, 1909, be located at 30 Church street, New York City.

On and after February 23, the Boston branch of Chas. A. Schieren Company, will be located at a new address, 643 and 645 Atlantic avenue.

The Prentiss Tool and Supply Company, of New York City, has secured the exclusive selling agency of the Norton Grinding Company for all of New England and New York.

The Hess-Bright Manufacturing Company, 21st street and Fairmount avenue, Philadelphia, has opened a store at 1974 Broadway (above 66th street). Geo. T. Gwilliam, resident manager.

The Campbell Iron Company, of St. Louis, Mo., has recently completed arrangements for the erection of two 3-story and basement modern warehouses which it expects to occupy in a few months.

The Metal Products Corporation has recently been organized and will occupy a new manufacturing building in Providence, R. I. This company was formerly the Geo. W. Dorer Company of that city.

The Hoskins Company, of Chicago, manufacturer of scientific electrical apparatus for analyzing and testing steel, has been reorganized under the name of the Hoskins Manufacturing Company, and has removed its plant to 453-471 Lawton avenue, Detroit, Mich.

G. E. Wilson, with the Star Machine Works of Indianapolis for the last fifteen years, and W. O. Parsons, with the same firm for the past five years, have opened an office and shops at 224-226-228 W. Maryland street, where they will make a specialty of all kinds of canning and preserving machinery and will manufacture all kinds of special machinery.

The American Specialty Company, of Chicago, has closed a contract with the High Speed Drill Company, of Dubuque, Iowa, whereby they take the entire output of the drill company and become the exclusive sales agents for the complete line of the flat and flat-twisted high speed drills. This line comprises machine shop, structural, blacksmith, ratchet, track drills, etc.

The Franklin Moore Company, Winsted, Conn., has just opened a branch at 136 Liberty street, New York City, with A. H. Briggs in charge. A full line of their trolleys for flat rails and their Acme differential and new Imperial chain hoists will be carried in stock so that immediate deliveries will be made in New York City and vicinity from this branch.

Business Opportunities

William Schuting, Baltimore, Md., will erect box factory.

The Plainville (Ind.) Canning Company, a new concern, will erect factory.

The Virginia Bridge and Iron Works, Roanoke, Va., will erect addition to plant.

The Letort Axle Works, Carlisle, Penn., was burned. Loss about $125,000.

The Brown Truck Company, Omaha, Neb., will build a new factory at Ralston.

The Ringsville (Tex.) Gin Company will rebuild plant recently destroyed by fire.

The Oklahoma Iron Works, Tulsa, Okla., has purchased site for foundry and steel plant.

The sawmill of the Marbury (Ala.) Lumber Company was burned. Loss about $40,000.

The J. G. Brill Car Works, Philadelphia, Penn., will erect a new three-story factory.

Mitchell & Van Meter, Pottstown, Penn., are having plans prepared for a brass foundry.

The Standard Table Oil Cloth Company, Davenport, Iowa, will erect a $100,000 addition.

The foundry of the Cahill Iron Works, Chattanooga, Tenn., was burned. Loss about $20,000.

The Central Stamping Company, Newark, N. J., has awarded contract for the construction of new plant.

The planing mill of Joubert & White, Glens Falls, N. Y., was destroyed by fire. Loss, $20,000.

The planing mill of the Foster-Latimer Company, Mellen, Wis., was destroyed by fire. Loss, $20,000.

The car repair shops of the New York Central Railroad at Lyons, N. Y., were burned. Loss, $20,000.

The Plant of the People's Woodworking Company, Tulsa, Okla., was destroyed by fire. Loss, $40,000.

Plans have been completed by the Pennsylvania Railroad for proposed boiler shops at Renovo, Penn.

The National Tube Company, Pittsburg, Penn., will spend $750,000 in improvements at its plants in Ellwood City.

The Vandalia Railroad Company is to build an additional roundhouse at Terre Haute at a cost of $100,000.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

Small die and sheet stampings. Whitman & Hunter, Ypsilanti, Mich.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Engine lathe, 24" to 28"x14' or more; also 14" to 16"x8' or more. Box 930, AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Special machinery designed, new ideas developed to practical results. Detail drawings made. Prices reasonable. Box 920, AM. MA.

Wanted—To learn of good location for repair and jobbing machine shop, equipped for engine and motor boat work. River town in Central States preferred. Box 952, AMERICAN MACH.

Machinery designed and improved by technical expert; graduate electrical and mechanical engineer. Working drawings, patterns and castings furnished. R. P. Clarkson, Beverly, Mass.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

I desire to purchase an interest in a business making machinery and castings, and take the superintendency of the plant or entire management of the business. I am thoroughly well qualified by experience, reputation and ability to produce profitable results. Address Box 936, AMERICAN MACHINIST.

In order to settle an estate an attractive opportunity is open to a party with $150,000.00, competent to fill responsible position either in the sales or manufacturing department, to purchase an interest in a well and favorably known, profitable machinery manufacturing plant located in Pennsylvania, with an office and established trade in New York City. Address "Executors," care of AMERICAN MACH.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Mechanical engineer, member A. S. M. E., expert on highest grade interchangeable work, 25 years' experience. Competent manager, superintendent or chief engineer. Experience embraces manufacture of automobiles, typesetting machines, firearms and typewriters. Box 913, AMERICAN MACHINIST.

CONNECTICUT

Wanted—Position as supervising engineer; reduction of manufacturing costs a specialty; Ten years' experience in this country and abroad. Box 960, AMERICAN MACHINIST.

ILLINOIS

Tool draftsman, age 24, on special machinery, jigs and dies for interchangeable work. Five years' shop experience. Chicago or vicinity preferred. Box 963, AM. MACH.

INDIANA

Superintendent—Practical machinist and toolmaker. Wide experience handling men and producing results. Age 38. Now employed. Will go anywhere. Box 877, AMER. MACH.

Wanted—Position as general superintendent by thoroughly practical mechanic. Familiar with modern shop and foundry practice. Shop time and cost systems. Clever designer of jigs, special tools and short cuts for economical production. Am on third year with present company, but change of management in near future necessitates change for us. Will furnish gilt edge reference and can show splendid record. Box 947, AMERICAN MACHINIST.

MASSACHUSETTS

I wish to correspond with any company desiring the services of a progressive and up-to-date manufacturing superintendent. Box 953, AMERICAN MACHINIST.

Graduate mechanical engineer, first class designer with excellent experience in steam turbines, pumps and general machinery, would like position as designing engineer or chief draftsman. References of well known concerns. Box 929, AMERICAN MACHINIST.

MICHIGAN

Young man desires position as machine shop foreman with firm manufacturing motor cars. Formerly connected with one of the largest firms in the business. Box 948, AMER. MACH.

NEW JERSEY

Technical graduate, 20 years' experience as mechanical engineer, master mechanic and superintendent of construction in mill work, desires position; best of references. Box 958, AMERICAN MACHINIST.

NEW YORK

Draftsman, experienced, seeks position. Box 962, AMERICAN MACHINIST.

Automobile and gas engine designer with several years' experience, wants position. Box 933, AMERICAN MACHINIST.

Experienced mechanical draftsman, practical and theoretical, technical graduate, open for engagement. Box 932, AMER. MACHINIST.

Designer wishes position in New York City; wide experience in developing automatic machines, tools and fixtures. Box 961, AMERICAN MACHINIST.

Progressive, up-to-date superintendent, in present position three years, wants to change. A good shop organizer and cost reducer. Minimum salary, $2500.00. "High Class," AM. MA.

OHIO

Mechanical engineer with experience as designer, chief draftsman and superintendent, wants change. Technical training, shop practice and good executive ability. Prefer company that wants to manufacture pumps, compressors and engines from my design or wants to improve their line. Box 946, AMER. MACH.

PENNSYLVANIA

First-class designer and draftsman with 12 years' experience on steam turbines, steam engines—marine and stationary, general arrangement plans and auxiliary machinery; desires to change. Box 951, AMERICAN MACHINIST.

FOREIGN

Man, 42 years of age, with 15 years' experience as works manager, and 6 years' foreign sales manager, desires position as latter at London, with A-1 American engineering firm. Thoroughly familiar with English and Continental business; up-to-date hustler. Box A.2, AMERICAN MACHINIST, 6 Bouverie Street, London, E. C., England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent Wanted — Experienced manufacturing and assembling adding machines, typewriters or small tools. Must be educated in mechanics, experienced and qualified to lay out and direct work and to handle men. Should understand factory organization, shop production and economy. Write, stating experience, place and date of birth and salary to go to Canada. Good opportunity and chance for advancement to a wide-awake, progressive man. Address "L. A. W.," care AMERICAN MACHINIST.

INDIANA

Wanted—4 toolmakers, 6 lathe men, 1 foreman. Good wages, steady employment. Box 943, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Machinist, experienced as toolmaker and foreman. Address stating age, experience and pay required. Box 944, AM. MA.

NEW JERSEY

Wanted—Two competent draftsmen familiar with printing presses or kindred machinery. State age, references, experience and salary. Box 945, AMERICAN MACHINIST.

Wanted—Working foreman to take charge of 10 or 12 milling machines, turret lathes, and drill presses. A hustler, able to keep machines up to concert pitch. Good chance for young man wishing to advance. Box 927, AMERICAN MACHINIST.

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

In our rapidly growing business of the manufacture of a well known article, we always have openings for draftsmen and toolmakers on small tools, jigs, sub-press dies and special machinery. We invite applications from first-class men on this kind of work. Box 884, AMERICAN MACHINIST.

NEW YORK

Wanted—First-class die maker. Steady employment to right man. Standard Optical Co., Geneva, N. Y.

Wanted—Turret lathe hands and toolmakers. In replying state experience, references and wages required. The Georgian Manufacturing Company, Binghamton, N. Y.

Wanted—Man familiar with laying out and selling power transmission machinery. State age, experience, reference and salary expected. P. O. Box 2062, New York City.

Wanted—First-class blacksmith and tool dresser, one who understands high-speed tool steels. Shop in small country town. Applicant must state age, wages expected and give references. Box 964, AMER. MACH.

Wanted—Master boilermaker at $6.24 per diem. A competitive examination will be held at the Navy Yard, Brooklyn, N. Y., February 26, 1909, to fill the above position. For application and further information address, "Commandant," Navy Yard, Brooklyn, N. Y.

Wanted—Editorial assistant on mechanical journal. Ability to write good English and practical engineering or shop experience essential; technical education desirable but not necessary. Capable draftsman who reads and writes for technical papers might be adapted for position. State particulars fully. Box 957, AMERICAN MACHINIST.

Chief draftsman; we want a man who has had extensive experience on both small and large work along the line of motors, generators and other electrical machinery. He should be a good executive and thoroughly up-to-date. Write in confidence, giving full information, age and salary expected. Box 959, AMERICAN MACHINIST.

Engineer—We want a technical man for position as engineer of methods. One to do general experimenting and investigating on power apparatus machinery. Must be thoroughly familiar with shop methods and processes. In answer, state fully in detail your experience, age and salary expected. Your answers will be treated in confidence and should a personal interview be desired, it will be arranged for later. Box 904, AMERICAN MACH.

OHIO

Wanted—First-class salesman for presses and hammers. Box 955, AMERICAN MACHINIST.

Wanted—An A-1 machine tool salesman for Middle West. Only experienced man on high grade tools. Box 954, AMERICAN MACHINIST.

PENNSYLVANIA

Shop Superintendent—Experienced man to take charge of manufacturing in electric elevator works located in Pennsylvania. Excellent opportunity for bright, active man. Address immediately, giving full particulars as to qualifications and salary expected. Box 949, AMERICAN MACHINIST.

Wanted—First-class, energetic foreman, to take charge of machine shop employing 100 men, on light and medium heavy special machinery. State age, experience, salary expected, references and when you can start work. Box 950, AMERICAN MACHINIST.

Wanted—Mechanical draftsman, one experienced in elevators preferred; state fully age, experience and salary expected, also how soon available. National Elevator & Machine Co., Honesdale, Pa.

Wanted—Chief draftsman of good designing ability. A first-class man with wide experience covering hoisting engines and general machinery, boiler and steam plants. Prefer a man with college education and of good executive ability. Good salary to a first-class man. In replying state experience and age, giving full particulars. Box 955, AMERICAN MACH.

TENNESSEE

Die maker, first-class man, familiar with small and medium sized novelties. State age, experience and pay wanted. Southern Stamping & Mfg. Co., Nashville, Tenn.

For Sale

Patents for sale of heavy machine tools well introduced or owner will take part cash, royalty or stock in a company of responsibility. Box 942, AMERICAN MACHINIST.

For Sale—Well equipped general machine shop in New Jersey, employing 24 hands and now running 13 hours per day and with good prospects for the future. Good reason for selling. Investigation solicited. Address "R," Box 1216, New York City.

English factory for sale covering about 6500 square yards and additional 10,000 square yards for extensions. 130 horsepower gas engines and up-to-date machinery, suitable for light manufacturing work of any kind. Factory situated in largest manufacturing center of the Midlands. Owners are open to manufacture and distribute under direct supervision large quantities of patented articles. Hill, Cawney House, Dudley, Worcestershire, England.

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Safety Emery Wheel Co., Springfield, O.
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Air Lifts

Ingersoll-Rand Co., New York.

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See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Cleveland Twist Drill Co., Cleveland, O.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Barrels, Steel

Boker & Co., Hermann, New York.
Lyon Metallic Mfg. Co., Aurora, Ill.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood Co., H. B., Philadelphia Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hess-Bright Mfg. Co., Philadelphia, Pa.
Hyatt Roller Bearing Co., Harrison, N. J.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Smooth-On Mfg. Co., Jersey City, N. J.

Belt Fasteners

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Greene, Tweed & Co., New York.

Belt Filler

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Smooth-On Mfg. Co., Jersey City, N. J.

Belt Lacing Machines

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifter

The L. & D. Co., Boston, Mass.

Belting, Chain

Link Belt Co., Phila., Pa.

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Chicago Raw Hide Mfg. Co., Chicago, Ill.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Phila., Pa.
Watson-Stillman Co., New York.

Bending Machines, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machines, Power

Bethlehem Fdry. & Mach. Co., South Bethlehem, Pa.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

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Nicholson & Co., W. H., Wilkes-Barre, Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Bolt and Nut Machinery

Acme Mchry. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
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National Machinery Co., Tiffin, O.
Newton Machine Tool Wks., Inc., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
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Bolt and Nut Machinery

Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
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Wiley & Russell Mfg. Co., Greenfield, Mass.
Lang Co., G.R., Meadville, Pa.

Bolts and Nuts

Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.

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Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.
Sames, Chas. M., Jersey City, N. J.
System, Chicago, Ill.

Boosters

C & C Electric Co., New York.
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General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Bearman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Detrick & Harvey Mach. Co., Wilmington, Del.
Fitchburg Machine Works, Fitchburg, Mass.
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Boring and Turning Mills, Vertical

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Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Flather Mfg. Co., E. J., Nashua, N. H.
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Marshall & Huschart Machinery Co., Chicago, Ill.
McCabe, J. J., New York.
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Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchi Co., New York

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.

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Industrial Oxygen Co., New York.
Sanford Mfg. Co., F. C., Bridgeport, Conn.
Universal Fluxine Co., Urbana, Ohio.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
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Buckets, Coal

Link Belt Co., Philadelphia, Pa.

Bulldozers

Bliss Co., E. W., Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers

Brown & Sharpe Mfg. Co., Providence, R. I.
Schuchardt & Schutte, New York.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams

Bligram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.
Fuller Manufacturing Co., New Haven, Conn.

Carborundum

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Carborundum Paper and Cloth

Carborundum Co., Niagara Falls, N. Y.

Cars, Industrial

Link Belt Co., Philadelphia, Pa.

Case-Hardening

American Gas Furnace Co., New York.
Rogers & Hubbard Co., Middletown, Conn.
Williams & Co., J. H., Brooklyn, N. Y

Castings, Brass and Bronze

Clum & Atkinson, Rochester, N. Y.
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded

Berry & Parker, Erie, Pa.
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Buffalo Fdry. & Mach. Co., Buffalo, N. Y.
Chisholm & Moore Mfg. Co., Cleveland, Ohio.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Link Belt Co., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.

Castings, Steel

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammell Laird & Co., New York.

Cast Iron Brazing

Industrial Oxygen Co., New York.
Sanford Mfg. Co., F. C., Bridgeport, Conn.

Cement, Cast Steel

Clark Cast Steel Cement Co., Shelton, Conn.
Obermayer & Co., S., Cincinnati, O

Cement, Iron

Smooth-On Mfg. Co., Jersey City, N. J.

Centering Machines

Hendey Mach. Co., Torrington, Conn.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer

Cincinnati Planer Co., Cincinnati, O
Fay & Scott, Dexter, Me.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

Chucking Machines

American Tool Wks. Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Garvin Mach. Co., New York.
Gisholt Machine Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Reed Co., F. E., Worcester, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Ashburnham, Mass.
Brown & Co., R. H., New Haven, Conn.
Celfor Tool Co., Buchanan, Mich.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morrow Mfg. Co., Elmira, N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
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Whitman & Barnes Mfg. Co., Chicago, Ill.
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Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cincinnati Chuck Co., Cincinnati, O.
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Gisholt Mach. Co., Madison, Wis.
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Niles-Bement-Pond Co., New York.
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Union Mfg. Co., New Britain, Conn.

Chuck, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.

Circuit Breakers

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.